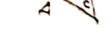
Mech Statics Equations

Force → lb ok!
kg · 9.81 = N ok!

Law of Cos & Sin
↳ $C = \sqrt{A^2+B^2-2AB\cos C}$
↳ $\frac{A}{\sin\alpha} = \frac{B}{\sin\beta} = \frac{C}{\sin\gamma}$



Unit Vector
↳ $u_A = \frac{\{A_x\vec{i} + A_y\vec{j} + A_z\vec{k}\}}{\sqrt{A_x^2 + A_y^2 + A_z^2}}$
↳ $\|u_A\| = 1$ dimensionless

Angle's
↳ $\cos\alpha = \frac{A_x}{A}$, $\cos\beta = \frac{A_y}{A}$
$\cos\gamma = \frac{A_z}{A}$
↳ $(\cos\alpha)^2 + (\cos\beta)^2 + (\cos\gamma)^2 = 1$
↳ $u_A = \{\cos\alpha\vec{i} + \cos\beta\vec{j} + \cos\gamma\vec{k}\}$

Position Vector
↳ $\vec{AB} = \vec{r}_{AB} = B - A$

Force Vector Along a Line
① Find $\vec{r}_{AB}$
② Find $\vec{u}_{AB} = \frac{\vec{r}_{AB}}{\|r_{AB}\|}$
* ③ $\vec{F} = \|F\|\vec{u}_{AB}$

Dot Product
$\vec{A}\cdot\vec{B} = \|A\|\|B\|\cos\theta = A_xB_x + A_yB_y + A_zB_z$

Equilibrium
$\Sigma F = \phi$ (components = ∅)
$\Sigma M_o = \phi$ (components = ∅)

Forces
Spring – $F = kx$ (displace* const)
Cable & pulley – $T_1 = T_2$
Moment (torque) – $M_o = \vec{F}d$ (⊥ dist)
$\Sigma M_o = F_1d_1 + F_2d_2 + \dots$
$M_o = \vec{r}\times\vec{F} = \|\vec{F}\|\|\vec{F}\|\sin\theta$
$M_{axis} = \vec{u}_{axis}\cdot(\vec{r}\times\vec{F})$
$M_{couple} = (\perp \text{dist btwn})\times\vec{F}$

Properly Aligned
3D supports do NOT have moments, but axles do!
↳ $M_x = M_y = M_z = \phi$

Distributed Loads
$\|\vec{F}\| \rightarrow dF = w(x)dx$
$\Sigma F \rightarrow \int dF = \int w(x)dx = A$ (total area)
$\Sigma M_o \rightarrow \bar{x}\int dF = \bar{x}\int w(x)dx = \bar{x}(\Sigma F)$


ex → $\Sigma F = Fx$


ex → $\Sigma F = \frac{1}{2}Fx$

Method of Joints
① Find ∅F members
② Find reaction forces
③ Draw variable forces in tension
④ Isolate joints for MoS to find forces, repeate for all unknowns

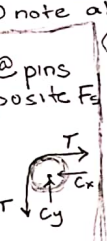
∅F members
↳ 2 noncolinear members w/ no xternal load or supports

↳ 3 members (2 colinear) w/ no xternal load or supports (non colinear is ∅F member)

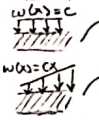
Method of Sections
① Cut the truss in 2 (generally cut the members ur looking for)
② pick the easier 1/2 & analyze
③ calculate support reactions if needed
④ apply equths equilibrium & solve

Frames & Machines
① break obj into parts
② multiforce members require F ↑↓ x @ pins
③ any connected objs exert = & opposite Fs

Pulleys & Chords (P&C)
→ FBD
① draw whole frame (including p&c)
② draw frame w/o p&c
③ draw pulley alone



Internal Forces
① Determine support reactions of whole beam
② draw cut @ desired location
③ draw FBD of each cut section (include internal forces)
④ pick easier section to solve
⑤ apply equations of equilibrium
→ V(x) & M(x) graphs
- left end is origin
- $w(x) = \frac{dV}{dx}$ (dist load = slope shear)
- $\int w(x) = \Delta V$
- $V = dM/dx$
- $\int V = \Delta M$

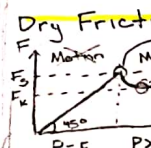


$w(x)=\emptyset \rightarrow V(x) = c$ constant, $M(x) = cx$ linear
$w(x)=c \rightarrow V(x) = cx$ linear, $M(x) = cx^2$ parabolic
$w(x)=cx \rightarrow V(x) = cx^2$ parabolic, $M(x) = cx^3$ cubic

- point loads are jumps in V
- couple moments $\Delta M = M_o$ on M(x)
  ↻ M_o jump up ↺ M_o jump down
- $V(x) = \phi \rightarrow M(x) = M_{max/peak}$

Buckling
- $P_{cr} = \frac{\pi^2 EI}{L^2}$ ← n<b for min I
▭ → $I = \frac{bh^3}{12}$ ○ → $I = \frac{\pi d^4}{64}$
- $\sigma_{cr} = P_{cr} \div A_{cross\ section}$
  ↳ if $\sigma_{cr} > \sigma_{yield}$ column will yeild b4 buckling
- $P_{safe} = P_{cr} \div FS$

Dry Friction



$F_s = \mu_sN$ @ brink of movement
$F_k = \mu_kN$ @ const movement
- $\mu_k < \mu_s$ $\Phi_{ang\ of\ P} = \tan^{-1}(\mu)$
- f acts opposite direction to movement
① draw FBD w/ friction forces
② determine # unknowns
③ use equations to solve
- types of problems
  ↳ no impending motion $F \le \mu_sN$
  ↳ impending motion @ all $F = \mu_sN$ or $F = \mu_kN$ (slipping)
  ↳ impending motion @ some # unknowns < # eqns + # f eqns (N = p)
- tipping → $F \le \mu_sN$, farthest pt leaves ground
- slipping → $F_s = \mu_sN$, $0 \le x \le \frac{a}{2}$

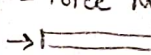
Vector Trick (probs midterm 1)
① note all forces (known & unknown)
② break down forces into $\hat{i}, \hat{j}$ & $\hat{k}$
↳ $\vec{F} = F\frac{\xi\hat{i} + \hat{j} + \hat{k}\}}{\sqrt{\xi^2+1^2+1^2}}$
③ write equations
↳ $\Sigma\hat{i}$, $\Sigma\hat{j}$, $\Sigma\hat{k}$, $M_o = \vec{r}\times\vec{F} + \vec{r}_2\times\vec{F}_2 + \dots$
($\vec{r}$ vector, point o to F)

Replace loading w/ single F_R
① add up all external forces
② do not add internal F, support F, or moments
Specify location of F_R from pt O
① find moment using everything except support F
② $M = F_Rd$ → d = dist from O

Couple Moments
↳ moment / rotation caused by 2 forces in opposite directions

↳ resultant $M = \|F\|d = \vec{r}\times\vec{F}$
↳ then treat as a moment

2 Force Member



← all external forces