Løsningsforslag (Fra Delprøve 2)
Katamaran med kran
Utvidet til å inkludere effekten av trim

Inngangsdata:

Tetthet sjøvann: $\rho_s := 1025\frac{kg}{m^3}$ $t \equiv kg\cdot 10^3$

Lengde i vannlinjen: $L := 12m$

Lengde baug: $L_b := 2.5m$

Lengde parallell del: $L_p := L - L_b$ $L_p = 9.5\,m$

Total bredde: $B := 5\cdot m$

Bredde skrog $B_s := 1.5m$

Dybde: $D := 1.7m$

Dypgang lettskip: $T_{ls} := 0.6m$

KG lettskip: $KG_{ls} := 1.6m$

Kran: $V_K := 1.5t$ $X_K := 4m$ $Y_K := -2m$ $Z_K := 2.5m$

Last: $V_L := 3t$ $X_L := 4.5m$ $Y_L := -3.5m$ $Z_L := 3.8m$

Beregninger:

Oppgave A

Vannlinjeareal: $A_{vl} := 2\cdot\left(L_p\cdot B_s + 0.5\cdot B_s\cdot L_b\right)$ $A_{vl} = 32.25m^2$

Deplasement lettskip: $\Delta_{ls} := A_{vl}\cdot T_{ls}\cdot\rho_s$ $\Delta_{ls} = 19.834t$

Tyngdepunkt lettskip: $X_{ls} := \dfrac{\left[L_p\cdot B_s\cdot\dfrac{L_p}{2} + 0.5B_s\cdot L_b\cdot\left(L_p + \dfrac{L_b}{3}\right)\right]\cdot T_{ls}\cdot 2}{\dfrac{\Delta_{ls}}{\rho_s}}$ $X_{ls} = 5.399m$

$Y_{ls} := 0m$

$Z_{ls} := KG_{ls}$ $Z_{ls} = 1.6\,m$

$KB_{ls} := \dfrac{T_{ls}}{2}$ $KB_{ls} = 0.3\,m$

$I_x := 2\cdot\left[\dfrac{L_p\cdot B_s^{\,3}}{12} + \dfrac{L_b\cdot B_s^{\,3}}{48} + \left(L_p\cdot B_s + 0.5L_b\cdot B_s\right)\cdot\left(\dfrac{B}{2} - \dfrac{B_s}{2}\right)^2\right]$ $I_x = 104.461m^4$

$BM_{tls} := \dfrac{I_x\cdot\rho_s}{\Delta_{ls}}$ $BM_{tls} = 5.398m$

$GM_{tls} := KB_{ls} + BM_{tls} - KG_{ls}$ $GM_{tls} = 4.098m$

Oppgave B

Nytt deplasement: $\Delta := \Delta_{ls} + V_K + V_L$ $\Delta = 24.334\,t$

Nytt tyngdepunkt: $X_G := \frac{\Delta_{ls} \cdot X_{ls} + V_K \cdot X_K + V_L \cdot X_L}{\Delta}$ $X_G = 5.202\,m$

$Y_G := \frac{\Delta_{ls} \cdot Y_{ls} + V_K \cdot Y_K + V_L \cdot Y_L}{\Delta}$ $Y_G = -0.555\,m$

$Z_G := \frac{\Delta_{ls} \cdot Z_{ls} + V_K \cdot Z_K + V_L \cdot Z_L}{\Delta}$ $Z_G = 1.927\,m$

Oppgave C

Ny dypgang: $T := \frac{\Delta}{A_{vl} \cdot \rho_s}$ $T = 0.736\,m$

Ny KB: $KB := \frac{T}{2}$ $KB = 0.368\,m$

Ny BM_t: $BM_t := \frac{I_x \cdot \rho_s}{\Delta}$ $BM_t = 4.4\,m$

Ny GM_t: $GM_t := KB + BM_t - Z_G$ $GM_t = 2.842\,m$

Krengevinkel (pos. babord): $\Phi := \operatorname{atan}\left(\frac{Y_G}{GM_t}\right)$ $\Phi = -11.048\,deg$

Minste fribord: $F := D - T - \frac{B}{2} \cdot \tan(|\Phi|)$ $F = 0.476\,m$

Mer nøyaktig beregning, se formelark:

Given

$GM_t \cdot \sin(\Phi) + 0.5\,BM_t \cdot \sin(\Phi) \cdot (\tan(\Phi))^2 - Y_G \cdot \cos(\Phi) = 0$

$\Phi := \text{Find}(\Phi)$

$\Phi = -10.754\,deg$

Minste fribord: $f_C := D - T - \frac{B}{2} \cdot \tan(|\Phi|)$ $f_C = 0.489\,m$

Oppgave D

Trim inkludert:

Tverrskips nøytralakse, eller langskips flotasjonssenter (LCF): $X_0 := X_{ls}$

Beregning av langskips GM:

$$I_y := 2\cdot\left[\frac{L_p^{\,3}\cdot B_s}{12} + \frac{L_b^{\,3}\cdot B_s}{36} + L_p\cdot B_s\cdot\left(\frac{L_p}{2} - X_0\right)^2 + 0.5\,L_b\cdot B_s\cdot\left(L_p + \frac{L_b}{3} - X_0\right)^2\right]$$

$I_y = 318.954\,m^4$

BM_l: $BM_l := \frac{I_y\cdot\rho_s}{\Delta}$ $BM_l = 13.435m$

GM_l: $GM_l := KB + BM_l - Z_G$ $GM_l = 11.877m$

Med vertikale sider og ender er LCB=LCF: $X_B := X_0$

Trimvinkel (pos. forover): $\Theta := \operatorname{atan}\left(\frac{X_G - X_B}{GM_l}\right)$ $\Theta = -0.951\,deg$

Minste fribord: $f_D := D - T - \frac{B}{2}\cdot\tan(|\Phi|) - X_0\cdot\tan(|\Theta|)$ $f_D = 0.399m$

Alternativt: $f_D := f_C - X_0\cdot\tan(|\Theta|)$ $f_D = 0.399m$