$$\int_0^t K(t-\tau)\,\nu(\tau)\,d\tau\,; \quad \nu(\tau)=\dot{z}(t)$$

$K(s)V(s)$; $K(s)$ can be written as $\underline{C_r}^T(s\underline{\underline{I}}-\underline{\underline{A_r}})^{-1}\underline{b_r} = \dfrac{b_n s^n + b_{n-1}s^{n-1}+\dots+b_1 s+b_0}{s^n+a_{n-1}s^{n-1}+\dots+a_1 s+a_0}$

here $b_n=0$

$$\dot{z}_r(t)=A_r z_r(t)+B_r\nu(t)$$

$$(s\underline{\underline{I}}-\underline{\underline{A_r}})Z_R(s)=B_r V(s)$$

$$Z_R(s)=(s\underline{\underline{I}}-\underline{\underline{A_r}})^{-1}\underline{B_r}V(s)$$

$$\underline{C_r}^T Z_R(s)=\underbrace{\underline{C_r}^T(s\underline{\underline{I}}-\underline{\underline{A}})^{-1}\underline{B_r}}_{K(s)}V(s)$$

$$\underline{C_r}^T Z_r(t)= K(t)*\nu(t)=\int_0^t K(t-\tau)\nu(\tau)d\tau = y_r(t)$$

①: radiation force: $F_{rad}(t)=-m_\infty\ddot{z}(t)-\int_0^t K(t-\tau)\nu(\tau)d\tau$

m_∞: added mass at infinite frequency; $K(t)$: radiation impulse.

②: wave excitation force: $F_{exc}(t)=Real\{\frac{H}{2}F_{exc}(\omega,\theta)e^{j\omega t}\}$

H: amplitude of wave; calculate $F_{exc}(\omega,\theta)$?

③: hydrostatic restoring force: $F_h(t)=\rho g V_1=\rho g(V_0-S z(t))$; set: $V_0=0$

Let: hydrostatic stiffness $S_h=\rho g S \Rightarrow F_h(t)=-S_h z(t)$

$$m\ddot{z}(t)=F_{rad}+F_{exc}+F_{PTO}+F_h$$

$$m\ddot{z}(t)=-m_\infty\ddot{z}(t)-\int_0^t K(t-\tau)\dot{z}(\tau)d\tau+F_{exc}(t)+F_{PTO}(t)-S_h z(t)\,; \quad \nu(t)=\dot{z}(t)$$

$$(m_\infty+m)\ddot{z}(t)+S_h z(t)+\underbrace{\int_0^t K(t-\tau)\dot{z}(\tau)d\tau}_{C_r^T Z_r(t)}=F_{exc}(t)+F_{PTO}(t)$$

$$(m_\infty+m)\ddot{z}(t)+S_h z(t)+C_r^T Z_r(t)=F_{exc}(t)+F_{PTO}(t)$$

$$\ddot{z}(t)=-\frac{1}{m+m_\infty}S_h z(t)-\frac{1}{m+m_\infty}C_r^T Z_r(t)+\frac{1}{m+m_\infty}F_{exc}(t)+\frac{1}{m+m_\infty}F_{PTO}(t)$$

Let: $x(t)=(x_1(t)\ \ x_2(t)\ \ x_3(t))^T=(z(t)\ \ \dot{z}(t)\ \ Z_r(t))^T$