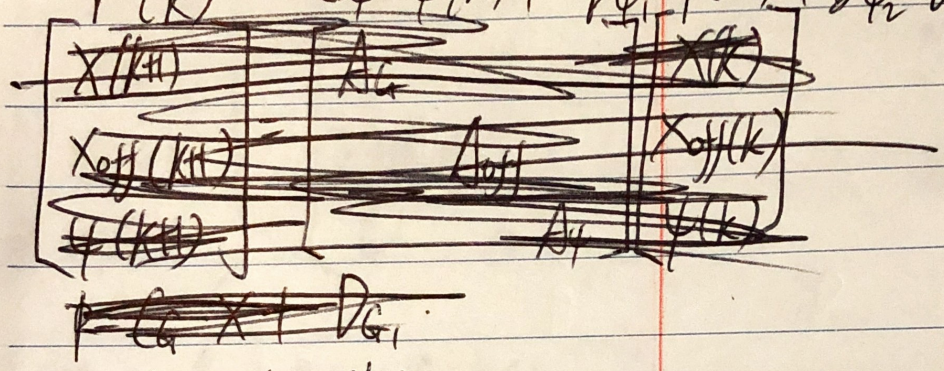
$$\begin{cases} X_G(k+1) = A_G X(k) + B_{G_1} q(k) + B_{G_2} u_{sat}(k) \\ X_{off}(k+1) = A_{off} X_{off}(k) + B_{off_1} v_\phi(k) + B_{off_2} w_\phi(k) \\ \psi(k+1) = A_\psi \psi(k) + B_{\psi_1} p(k) + B_{\psi_2} q(k) \\ r(k) = C_\psi \psi(k) + D_{\psi_1} p(k) + D_{\psi_2} q(k) \end{cases}$$



- $p(k) = u_{sat}(k)$

$$\Rightarrow \begin{aligned} X(k+1) &= A_G X(k) + B_{G_1} q(k) + B_{G_2} u_{sat}(k) \\ X_{off}(k+1) &= A_{off} X_{off}(k) + B_{off_1} v_\phi(k) + B_{off_2} w_\phi(k) \\ \psi(k+1) &= A_\psi \psi(k) + B_{\psi_1} u_{sat}(k) + B_{\psi_2} q(k) \end{aligned}$$

$$\begin{bmatrix} X(k+1) \\ X_{off}(k+1) \\ \psi(k+1) \end{bmatrix} = \begin{bmatrix} A_G & & \\ & A_{off} & \\ & & A_\psi \end{bmatrix} \begin{bmatrix} X(k) \\ X_{off}(k) \\ \psi(k) \end{bmatrix} + \begin{bmatrix} B_{G_2} & B_{G_1} & 0 & 0 \\ 0 & 0 & B_{off_1} & B_{off_2} \\ B_{\psi_1} & B_{\psi_2} & 0 & 0 \end{bmatrix} \begin{bmatrix} u_{sat}(k) \\ q(k) \\ v_\phi(k) \\ w_\phi(k) \end{bmatrix}$$

$$\begin{bmatrix} X(k) \\ X_{off}(k) \\ \varphi(k) \\ U_{sat}(k) \\ q(k) \\ U_{\phi}(k) \\ W_{\phi}(k) \end{bmatrix} = \begin{bmatrix} I & & & & & & \\ & I & & & & & \\ & & I & & & & \\ 0 & 0 & 0 & [0_{n_u \times (n_1+n_2)}, I_{n_3}] & & 0 & \\ 0 & 0 & 0 & 0 & & I & \\ \text{blkdiag}([W_1, 0_{n_\phi \times (n_\phi+n_q)}], W_2[W_3, 0_{n_\phi \times n_q}]) & & & & & 0 & \\ 0 & 0 & 0 & I & & & \end{bmatrix} \begin{bmatrix} X(k) \\ X_{off}(k) \\ \varphi(k) \\ W_{\phi}(k) \\ q \end{bmatrix}$$

$$X(k+1) = A_G X(k) + B_{G1} q(k) + B_{G2} U_{sat}(k) + B_{cur} \cdot Cur$$

$$X^* = A_G X^* + B_{G1} q^* + B_{G2} U_{sat}^* + B_{cur} \cdot Cur$$

$$X(k+1) - X^* = A_G (X(k) - X^*) + B_{G1} (q(k) - q^*) + B_{G2} (U_{sat}(k) - U_{sat}^*)$$