

Observer Pole Placement in OCF

$$\dot{x} = Ax, \quad y = Cx, \quad \dot{\hat{x}} = (A - LC)\hat{x} + Ly$$
$$A - LC = \begin{pmatrix} 0 & 0 & \dots & 0 & -(a_n + \ell_1) \\ 1 & 0 & \dots & 0 & -(a_{n-1} + \ell_2) \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \dots & 0 & -(a_2 + \ell_{n-1}) \\ 0 & 0 & \dots & 1 & -(a_1 + \ell_n) \end{pmatrix}$$

Eigenvalues of $A - LC$ are the roots of the characteristic polynomial

$$\begin{aligned} \det(Is - A + LC) \\ = s^n + (a_1 + \ell_n)s^{n-1} + \dots + (a_{n-1} + \ell_2)s + (a_n + \ell_1) \end{aligned}$$

Key observation: In OCF, each observer gain affects only *one* of the coefficients of the characteristic polynomial, which can be assigned arbitrarily by a suitable choice of ℓ_1, \dots, ℓ_n .

Hence the name **Observer Canonical Form** — convenient for observer design.