From State-Space to Transfer Function

$$y_\ell = \sum_{j=1}^{n} c_{\ell j} x_j + \sum_{k=1}^{m} d_{\ell k} u_k$$

$$\downarrow \mathscr{L}$$

$$Y_\ell(s) = \sum_{j=1}^{n} c_{\ell j} X_j(s) + \sum_{k=1}^{m} d_{\ell k} U_k(s), \qquad \ell = 1, \dots, p$$

Write down in matrix-vector form:

$$\begin{aligned}
Y(s) &= CX(s) + DU(s) \\
&= C\left[(Is - A)^{-1}x(0) + (Is - A)^{-1}BU(s)\right] + DU(s) \\
&= C(Is - A)^{-1}x(0) + \left[C(Is - A)^{-1}B + D\right]U(s)
\end{aligned}$$

To find the input-output t.f., set the IC to 0:

$$Y(s) = G(s)U(s), \qquad \text{where } G(s) = C(Is - A)^{-1}B + D$$