and express the constants A, B, C, D, and E in terms of the constants a_0, a_1, a_2, b_0, b_1, and b_2.

(b) Show that S may be considered a cascade connection of the following two causal LTI systems:

$$S_1 : y_1(t) = Cx_1(t) + D\int_{-\infty}^{t} x_1(\tau)\,d\tau + E\int_{-\infty}^{t}\left(\int_{-\infty}^{\tau} x_1(\sigma)\,d\sigma\right)d\tau,$$

$$S_2 : y_2(t) = A\int_{-\infty}^{t} y_2(\tau)\,d\tau + B\int_{-\infty}^{t}\left(\int_{-\infty}^{\tau} y_2(\sigma)\,d\sigma\right)d\tau + x_2(t).$$

(c) Draw a block diagram representation of S_1.

(d) Draw a block diagram representation of S_2.

(e) Draw a block diagram representation of S as a cascade connection of the block diagram representation of S_1 followed by the block diagram representation of S_2.

(f) Draw a block diagram representation of S as a cascade connection of the block diagram representation of S_2 followed by the block diagram representation of S_1.

(g) Show that the four integrators in your answer to part (f) may be collapsed into two. The resulting block diagram is referred to as a *Direct Form II* realization of S, while the block diagrams obtained in parts (e) and (f) are referred to as *Direct Form I* realizations of S.

EXTENSION PROBLEMS

2.61. **(a)** In the circuit shown in Figure P2.61(a), $x(t)$ is the input voltage. The voltage $y(t)$ across the capacitor is considered to be the system output.

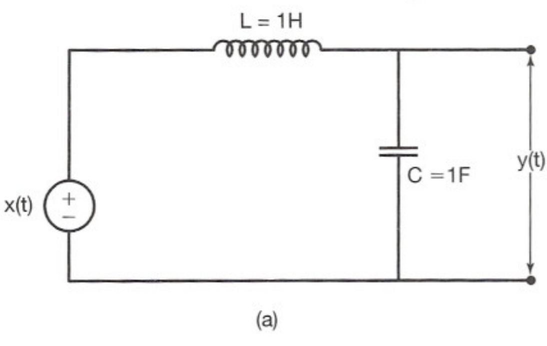

Figure P2.61a

(i) Determine the differential equation relating $x(t)$ and $y(t)$.

(ii) Show that the homogeneous solution of the differential equation from part (i) has the form $K_1 e^{j\omega_1 t} + K_2 e^{j\omega_2 t}$. Specify the values of ω_1 and ω_2.

(iii) Show that, since the voltage and current are restricted to be real, the natural response of the system is sinusoidal.