

Universidad Autónoma de Baja California
Facultad de Ciencias Químicas e Ingeniería



SEÑALES Y SISTEMAS
Ejercicios para practicar

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$$\textcircled{1} \quad F(s) = \frac{8}{s^2 - 6s + 25} = \frac{8}{(s - (3+4i))(s - (3-4i))}$$

$$F(s) = \frac{a}{s - (3+4i)} + \frac{b}{s - (3-4i)}$$

$$a = \frac{8}{s - (3+4i)} \Big|_{s=3+4i} = \frac{8}{(3+4i) - (3-4i)} = \frac{8}{8i} = i^{-1} = -i$$

$$b = \frac{8}{s - (3-4i)} \Big|_{s=3-4i} = \frac{8}{(3-4i) - (3+4i)} = \frac{8}{-8i} = -i^{-1} = i$$

$$F(s) = \frac{-i}{s - (3+4i)} + \frac{i}{s - (3-4i)}$$

$$-ie^{(3+4i)t} + ie^{(3-4i)t}$$

$$-ie^{3t}e^{4it} + ie^{3t}e^{-4it}$$

$$-ie^{3t}(\cos 4t + i\sin 4t) + ie^{3t}(\cos 4t - i\sin 4t)$$

$$-ie^{3t}\cos 4t - i^2e^{3t}\sin 4t + ie^{3t}\cos 4t - i^2e^{3t}\sin 4t$$

$$2e^{3t}\sin 4t$$

$$\textcircled{2} \quad F(s) = \left(\frac{62}{s^5} - \frac{12}{s^4} + \frac{4}{s+3} - \frac{10}{s^2+2s} + \frac{3s}{s^2+4} \right) e^{-2s}$$

$$62 \int \frac{e^{-2s}}{s^5} - 12 \int \frac{e^{-2s}}{s^4} + 4 \int \frac{e^{-2s}}{s+3} - 10 \int \frac{e^{-2s}}{s^2+2s} + 3 \int \frac{se^{-2s}}{s^2+4}$$

$$F(t) = \frac{31}{12}(t-2)^4 u(t-2) - 2(t-2)^3 u(t-2) + 4e^{-3(t-2)} - 2\sin 5(t-2) +$$

$$+ 3\cos 2(t-2)$$

③
$$F(s) = \frac{4s^2 - 4s + 2}{(s-1)^2} = \frac{4s^2 - 4s + 2}{s^2 - 2s + 1}$$

$$F(s) = 4 + \frac{11s - 2}{(s-1)^2}$$

$$F(s) = 4 + \frac{11s}{(s-1)^2} - \frac{2}{(s-1)^2}$$

$$P_{aux} = F(s) \text{ (ordenado)} = \frac{11s}{(s-1)^2} - \frac{2}{(s-1)^2}$$

$$\lambda_1 = P_{aux} \big|_{s=1} = 11 - 2 = 9$$

$$\lambda_2 = \frac{d}{ds} P_{aux} \big|_{s=1} = 11 - 2 = 9$$

$$F(s) = \frac{11}{(s-1)} + \frac{11}{(s-1)^2} - \frac{2}{(s-1)^2}$$

$$F(t) = 11e^t + 11te^t - 2te^t$$

$$F(t) = 11t + 11e^t + 4te^t - 2te^t$$

$$F(t) = 11\delta(t) + 2te^t u(t) + 11e^t u(t) - 2te^t u(t)$$

$$\textcircled{4} \quad F(s) = \frac{1-5s}{s^2-2s-3} = \frac{1-5s}{(s-3)(s+1)}$$

$$a = \frac{1-5s}{s-3} \Big|_{s=3} = \frac{1-15}{-6} = \frac{14}{6} = \frac{7}{3}$$

$$b = \frac{1-5s}{s+1} \Big|_{s=-1} = \frac{1+5}{0} = \frac{6}{0} = -\frac{3}{2}$$

$$F(s) = \frac{7/3}{s-3} - \frac{3/2}{s+1}$$

$$F(t) = \left[\frac{7}{6} e^{-3t} u(t) - \frac{3}{2} e^{2t} u(t) \right]$$

$$\textcircled{5} \quad \frac{20-4s}{s^2-4s+20} = \frac{20-4s}{(s-(2+4i))(s-(2-4i))}$$

$$a = \frac{20-4s}{s-(2+4i)} \Big|_{s=2+4i} = \frac{20-4(2+4i)}{(2+4i)-(2-4i)} = \frac{12-16i}{8i} = -2 + \frac{3}{2}i$$

$$b = \frac{20-4s}{s-(2-4i)} \Big|_{s=2-4i} = \frac{20-4(2-4i)}{(2-4i)-(2+4i)} = \frac{12+16i}{-8i} = -2 - \frac{3}{2}i$$

$$F(s) = \frac{-2 + \frac{3}{2}i}{s-(2+4i)} + \frac{-2 - \frac{3}{2}i}{s-(2-4i)} \quad F(t) = (-2 + \frac{3}{2}i) e^{(2+4i)t} + (-2 - \frac{3}{2}i) e^{(2-4i)t}$$

$$e^{2t} (-2 + \frac{3}{2}i) [\cos 4t + i \sin 4t] + e^{2t} (-2 - \frac{3}{2}i) [\cos 4t - i \sin 4t]$$

$$= -2e^{2t} \cos 4t - \frac{3}{2} e^{2t} \sin 4t - 2e^{2t} \cos 4t + \frac{3}{2} e^{2t} \sin 4t$$

$$F(t) = -4e^{2t} \cos 4t - 3e^{2t} \sin 4t$$

Section 2

$$\textcircled{1} F(s) = \frac{s}{s^2+4} = \cos(2t)$$

$$\textcircled{2} F(s) = \frac{s+1}{(s+1)^2+2^2} = \frac{s+1}{(s+1)^2+2^2} = e^{-t} \cos 2t$$

$$\textcircled{3} F(s) = \frac{2s+4}{s^2+4s+3} = \frac{2s+4}{(s+1)(s+3)}$$

$$a = \frac{2s+4}{s+3} \Big|_{s=-1} = \frac{-2+4}{2} = 1 \quad F(s) = \frac{1}{s+1} + \frac{1}{s+3}$$

$$b = \frac{2s+4}{s+1} \Big|_{s=-3} = \frac{-6+4}{-5+1} = \frac{-2}{-4} = \frac{1}{2} \quad F(t) = e^{-t} u(t) + e^{-3t} u(t)$$

$$\textcircled{4} \frac{5s+13}{s(s^2+4s+13)} = \frac{5s+13}{s(s-(-2+3i))(s-(-2-3i))}$$

$$a = \frac{5s+13}{(s-(-2+3i))(s-(-2-3i))} \Big|_{s=0} = \frac{13}{(-2+3i)(-2-3i)} = \frac{13}{13} = 1$$

$$b = \frac{5s+13}{s(s-(-2-3i))} \Big|_{s=-2+3i} = -\frac{1}{2} - \frac{1}{2}i \quad F(s) = \frac{a}{s} + \frac{b}{s-(-2+3i)} + \frac{c}{s-(-2-3i)}$$

$$c = \frac{5s+13}{s(s-(-2+3i))} \Big|_{s=-2-3i} = -\frac{1}{2} + \frac{1}{2}i \quad a=t, \quad b=(-\frac{1}{2}-\frac{1}{2}i)e^{-2+3i}t, \quad c=(-\frac{1}{2}+\frac{1}{2}i)e^{-2-3i}t$$

$$F(t) = u(t) - e^{-2t} \cos 3t + e^{-2t} \sin 3t$$

$$\textcircled{5} F(s) = \frac{2s+1}{s+2} \quad s+2 \overline{) 2s+1} \quad F(s) = 2 - \frac{3}{s+2}$$

$$F(t) = 2\delta(t) - 3e^{-2t}$$

$$\textcircled{6} F(s) = \frac{s^2+6s+7}{s^2+3s+2} \quad s^2+3s+2 \overline{) s^2+6s+7} \quad F(s) = 1 + \frac{3s+5}{s^2+3s+2}$$

$$\frac{3s+5}{(s+1)(s+2)} \quad \frac{3s+5}{(s+1)(s+2)} = \frac{a}{s+1} + \frac{b}{s+2}$$

$$a = \frac{3s+5}{s+2} \Big|_{s=-1} = \frac{-3+5}{-1+2} = 2$$

$$F(s) = 1 + \frac{2}{s+1} + \frac{1}{s+2}$$

$$b = \frac{3s+5}{s+1} \Big|_{s=-2} = \frac{-6+5}{-2+1} = -1$$

$$F(t) = \delta(t) + 2e^{-t} + e^{-2t}$$

$$\textcircled{7} F(s) = \frac{s^3+2s^2+16}{s^2+36}$$

$$s^2+36 \overline{) s^3+2s^2+0s+16}$$

$$-s^3+0s^2-36s$$

$$0+2s^2-36s+16$$

$$-2s^2+0s-72$$

$$0-36s+56$$

$$F(s) = s+2 + \frac{-36s-56}{s^2+36}$$

$$\frac{-36s-56}{(s-6i)(s-(-6i))}$$

$$a = \frac{-36s-56}{s-(-6i)} \Big|_{s=6i} = -18 + \frac{14}{3}i$$

$$F(s) = s+2 + \frac{-18+\frac{14}{3}i}{s-(6i)} + \frac{-18+\frac{14}{3}i}{s-(-6i)}$$

$$b = \frac{-36s-56}{s-(6i)} \Big|_{s=6i} = -18 - \frac{14}{3}i$$

$$F(t) = \delta(t) + 2\delta(t) + \left(-18 + \frac{14}{3}i\right)e^{-6+6it} + \left(-18 - \frac{14}{3}i\right)e^{-6-6it}$$

$$\left(-18 - \frac{14}{3}i\right)[\cos 6t + i \sin 6t] + \left(-18 + \frac{14}{3}i\right)[\cos 6t - i \sin 6t]$$

$$-18 \cos 6t + \frac{14}{3} \sin 6t - 18 \cos 6t + \frac{14}{3} \sin 6t$$

$$-36 \cos 6t + \frac{28}{3} \sin 6t$$

$$F(t) = \delta'(t) + 2\delta(t) - 36 \cos 6t + \frac{28}{3} \sin 6t$$

$$F(s) = \frac{2 + 2s e^{-2s} + 4e^{-4s}}{s^2 + 4s + 13} = \frac{2}{s^2 + 4s + 13} + \frac{2s e^{-2s}}{s^2 + 4s + 13} + \frac{4e^{-4s}}{s^2 + 4s + 13}$$

$$s^2 + 4s + 13 = (s - (-2 + 3i))(s - (-2 - 3i))$$

$$a = \frac{2}{s - (-2 + 3i)} \Big|_{s = -2 + 3i} = \frac{1}{3} i \quad b = \frac{2}{s - (-2 - 3i)} \Big|_{s = -2 - 3i} = \frac{1}{3} i$$

$$FA(s) = \frac{-1/3i}{s - (-2 + 3i)} + \frac{1/3i}{s - (-2 - 3i)}$$

$$(-1/3i) e^{-2t + 3it} + (1/3i) e^{-2t - 3it}$$

$$(-1/3i) e^{-2t} [\cos 3t + i \sin 3t] + (1/3i) e^{-2t} [\cos 3t - i \sin 3t]$$

$$FA(t) = -\frac{2}{3} e^{-2t} \sin 3t$$

$$FB(s) = \frac{2s}{s - (-2 + 3i)} + \frac{1 - 2i}{s - (-2 - 3i)}$$

$$a = \frac{2s}{s - (-2 + 3i)} \Big|_{s = -2 + 3i} = 1 + \frac{2}{3} i \quad b = \frac{1 - 2i}{s - (-2 - 3i)} \Big|_{s = -2 - 3i} = 1 - \frac{2}{3} i$$

$$e^{-2t} (1 + \frac{2}{3} i) [\cos 3(t-2) + i \sin 3(t-2)] + e^{-2t} (1 - \frac{2}{3} i) [\cos 3(t-2) - i \sin 3(t-2)]$$

$$e^{-2t} (\cos 3(t-2) + \frac{2}{3} \sin 3(t-2) + e^{-2t} (\cos 3(t-2) + \frac{2}{3} \sin 3(t-2))$$

$$FB(t) = 2e^{-2(t-2)} \cos 3(t-2) + \frac{4}{3} e^{-2(t-2)} \sin 3(t-2)$$

$$FC(s) = \frac{4}{s - (-2 + 3i)} - \frac{2}{3} i \frac{1}{s - (-2 - 3i)}$$

$$a = \frac{4}{s - (-2 + 3i)} \Big|_{s = -2 + 3i} = -\frac{2}{3} i \quad b = \frac{4}{s - (-2 - 3i)} \Big|_{s = -2 - 3i} = \frac{2}{3} i$$

$$FC(t) = \frac{2}{3} i e^{-2t} [\cos 3t + i \sin 3t] - \frac{2}{3} i e^{-2t} [\cos 3t - i \sin 3t]$$

$$-\frac{2}{3} i e^{-2t} \sin 3t - \frac{2}{3} i e^{-2t} \sin 3t$$

$$FC(t) = -\frac{4}{3} e^{-2(t-4)} \sin 3(t-4)$$

$$F(t) = -\frac{2}{3} e^{-2t} \sin 3t + 2e^{-2(t-2)} \cos 3(t-2) + \frac{4}{3} e^{-2(t-2)} \sin 3(t-2) +$$

$$-\frac{4}{3} e^{-2(t-4)} \sin 3(t-4)$$

Identifique la función $f(t)$ cuya transformada de Laplace tiene las raíces del denominador $s = 2$, $s = -3 + 4i$, y $s = -3 - 4i$ y numerador 1.

$$F(s) = \frac{1}{(s-2)(s-(-3+4i))(s-(-3-4i))}$$

$$a = \frac{1}{(s-(-3+4i))(s-(-3-4i))} \Big|_{s=2} = \frac{1}{41}$$

$$b = \frac{1}{(s-2)(s-(-3-4i))} \Big|_{s=-3+4i} = -\frac{1}{32} - \frac{1}{40}i$$

$$c = \frac{1}{(s-2)(s-(-3+4i))} \Big|_{s=-3-4i} = -\frac{1}{32} + \frac{1}{40}i$$

$$F(s) = \frac{1/41}{s-2} + \frac{-1/32 - 1/40i}{s-(-3+4i)} + \frac{-1/32 + 1/40i}{s-(-3-4i)}$$

$$e^{2t}(-1/32 - 1/40i) [\cos 4t + i \sin 4t] + e^{-3t}(-1/32 + 1/40i) [\cos 4t - i \sin 4t]$$

$$e^{-3t}(-1/32 \cos 4t + 1/40 \sin 4t) + e^{-3t}(-1/32 \cos 4t + 1/40 \sin 4t)$$

$$f(t) = \frac{1}{41} e^{2t} u(t) - \frac{1}{16} e^{-3t} \cos 4t u(t) + \frac{1}{20} e^{-3t} \sin 4t u(t)$$