⑦ Übungen Bode-Diagramm

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Aufgabe 1: Review-Fragen

1. Warum schlug Bode vor, den Amplitudengang einer Frequenzantwort doppelt-logarithmisch darzustellen?
2. Definieren Sie Dezibel.
3. Was ist die Amplitude der Übertragungsfunktion bei einer Verstärkung von 14 dB

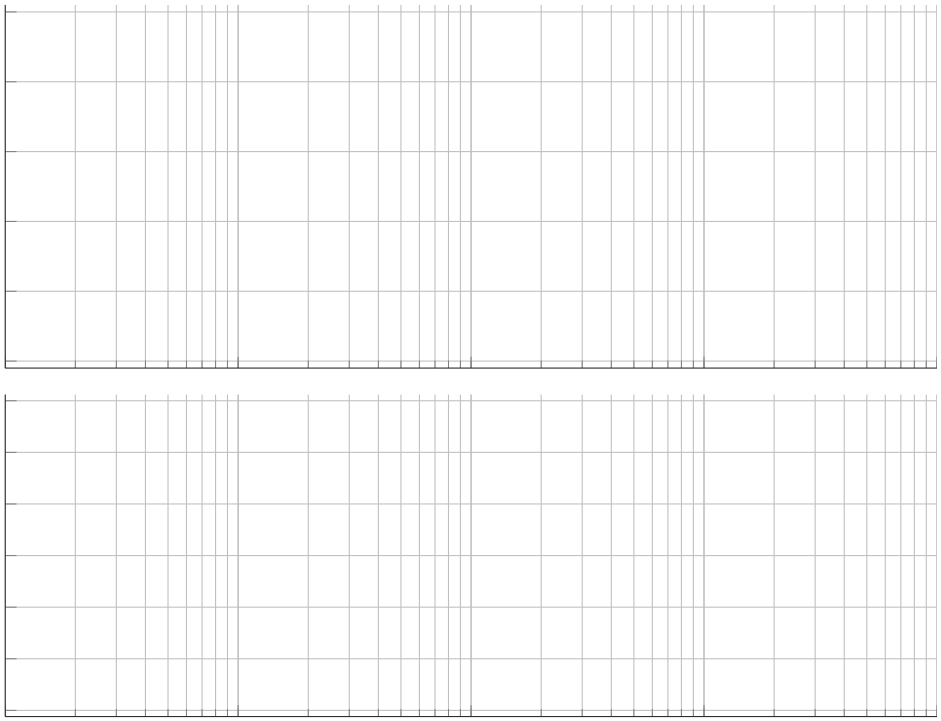
Aufgabe 2: Bode-Diagramm

Skizzieren Sie die Asymptoten des Amplituden- und Phasengangs folgender Übertragungsfunktionen. Verifizieren Sie Ihre Ergebnisse mit Hilfe von MATLAB.

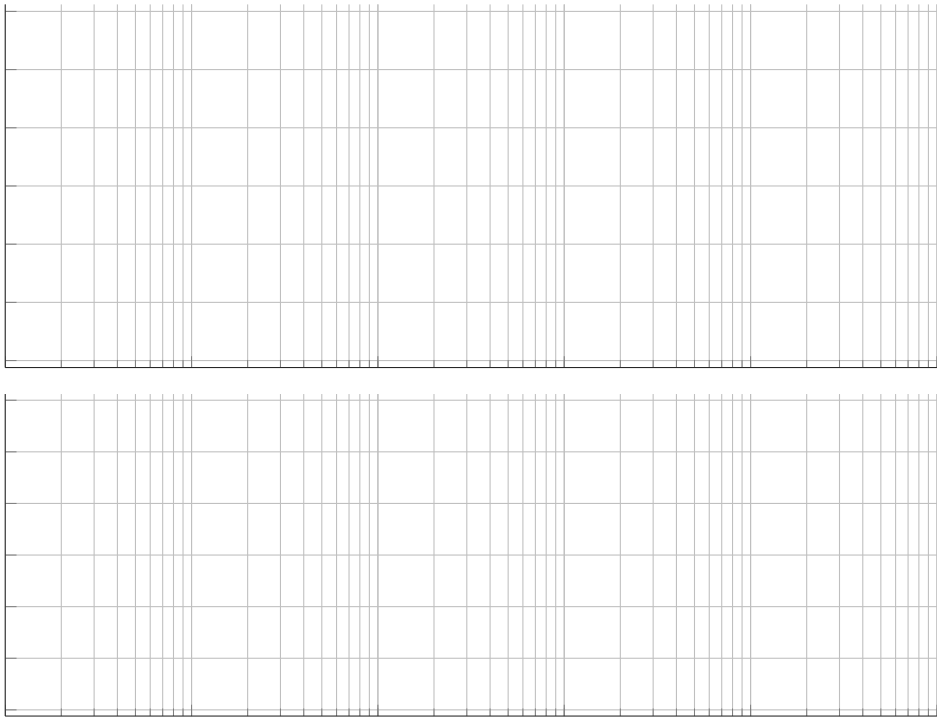
1. [FPE10, Aufgabe 6.3]
   (a) $L(s) = \dfrac{2000}{s(s+200)}$
   (b) $L(s) = \dfrac{100}{s(0.1s+1)(0.5s+1)}$
   (c) $L(s) = \dfrac{1}{s(s+1)(0.02s+1)}$
   (d) $L(s) = \dfrac{1}{(s+1)^2(s^2+2s+4)}$
   (e) $L(s) = \dfrac{10(s+4)}{s(s+1)(s^2+2s+5)}$
   (f) $L(s) = \dfrac{1000(s+0.1)}{s(s+1)(s^2+8s+64)}$
   (g) $L(s) = \dfrac{(s+5)(s+3)}{s(s+1)(s^2+s+4)}$
   (h) $L(s) = \dfrac{4s(s+10)}{(s+100)(4s^2+5s+4)}$
   (i) $L(s) = \dfrac{s}{(s+1)(s+10)(s^2+2s+2500)}$

(a)

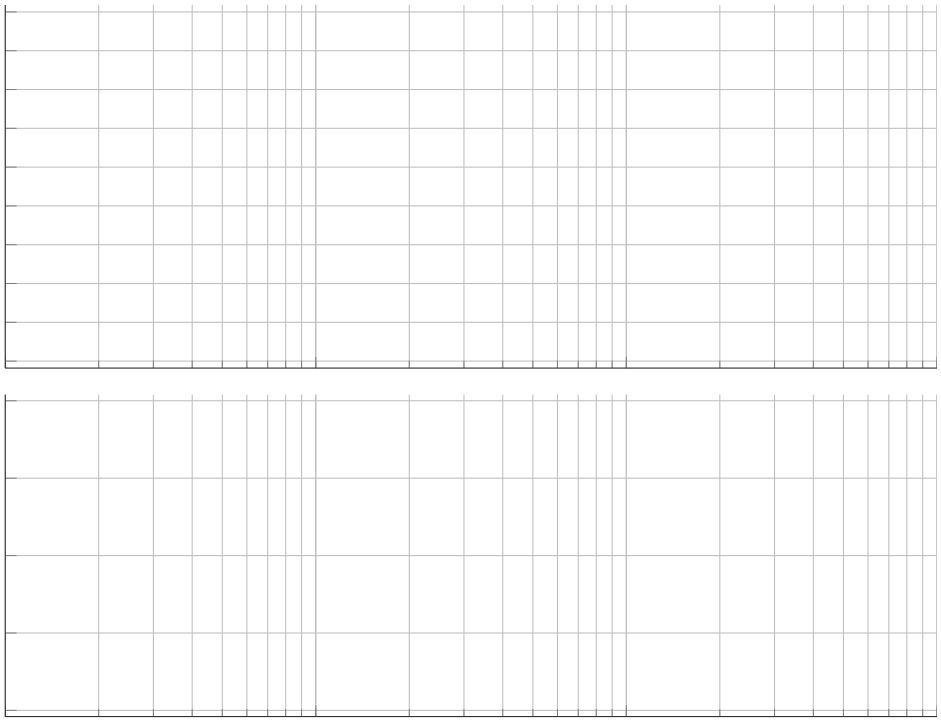
(b)



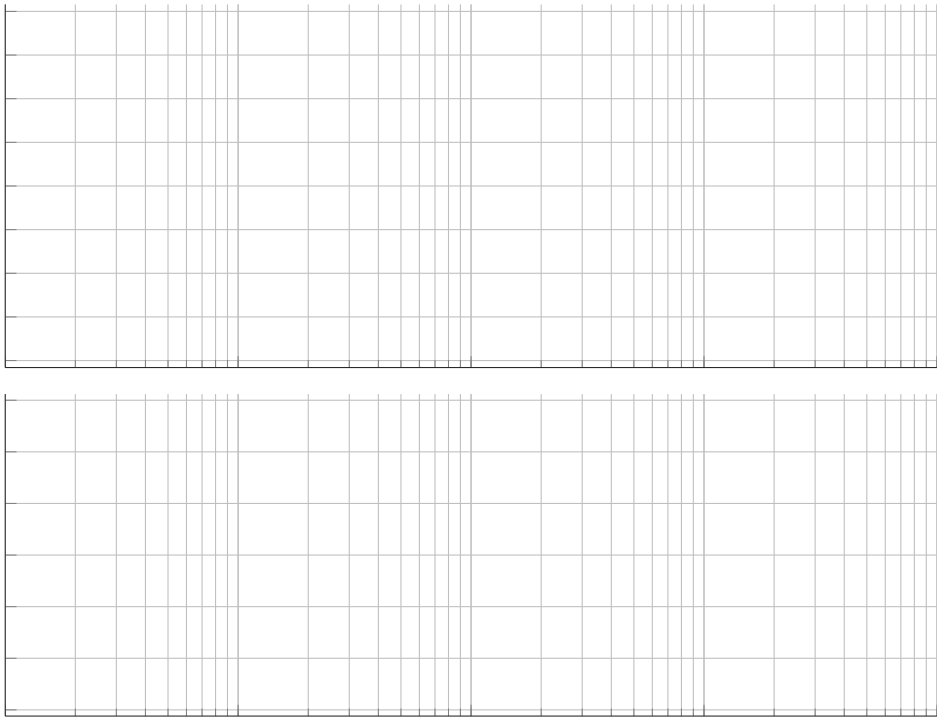
(c)



(d)

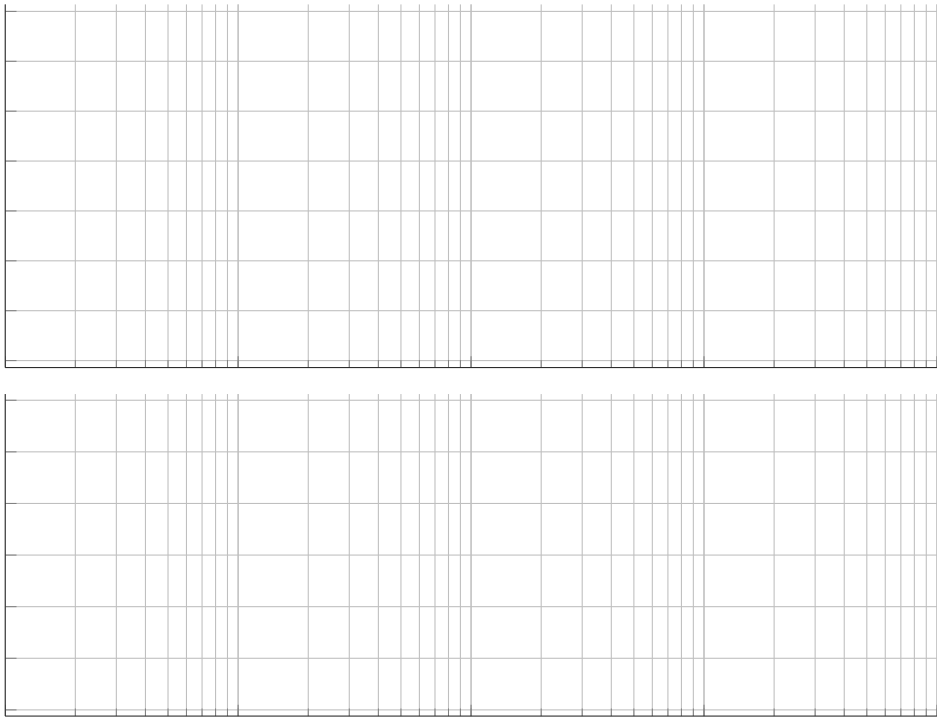


(e)

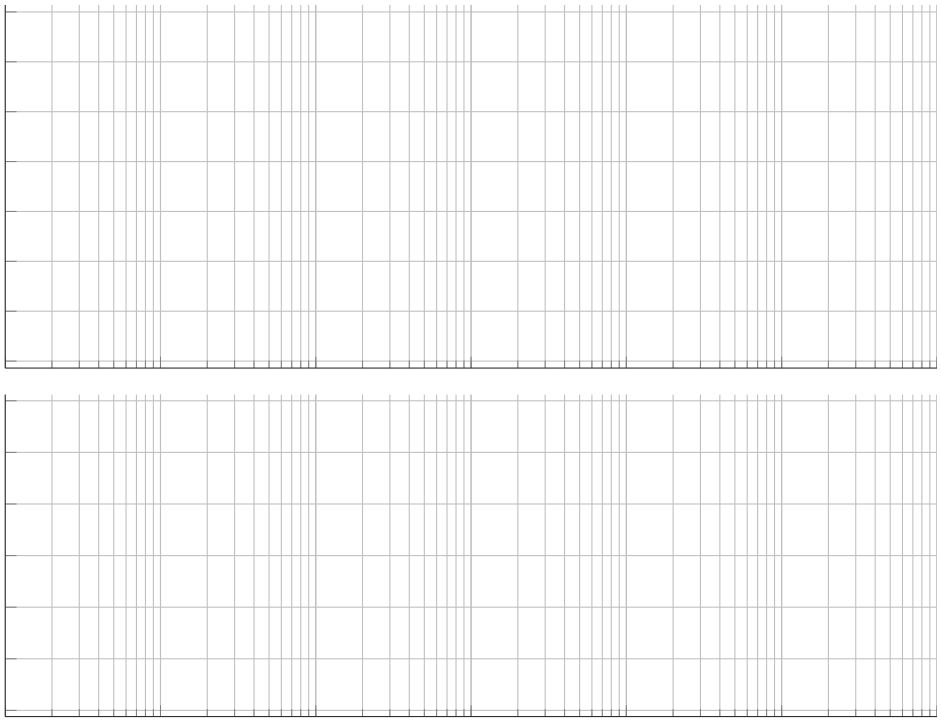


(f)

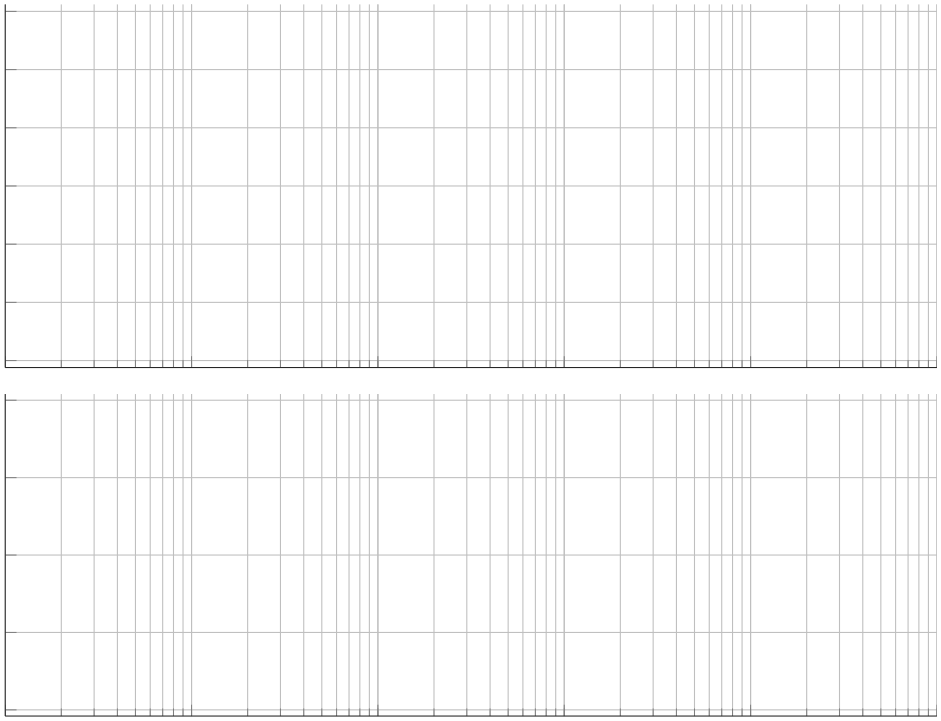
(g)



(h)



(i)



2. [FPE10, Aufgabe 6.4] Reelle Pole und Nullstellen.

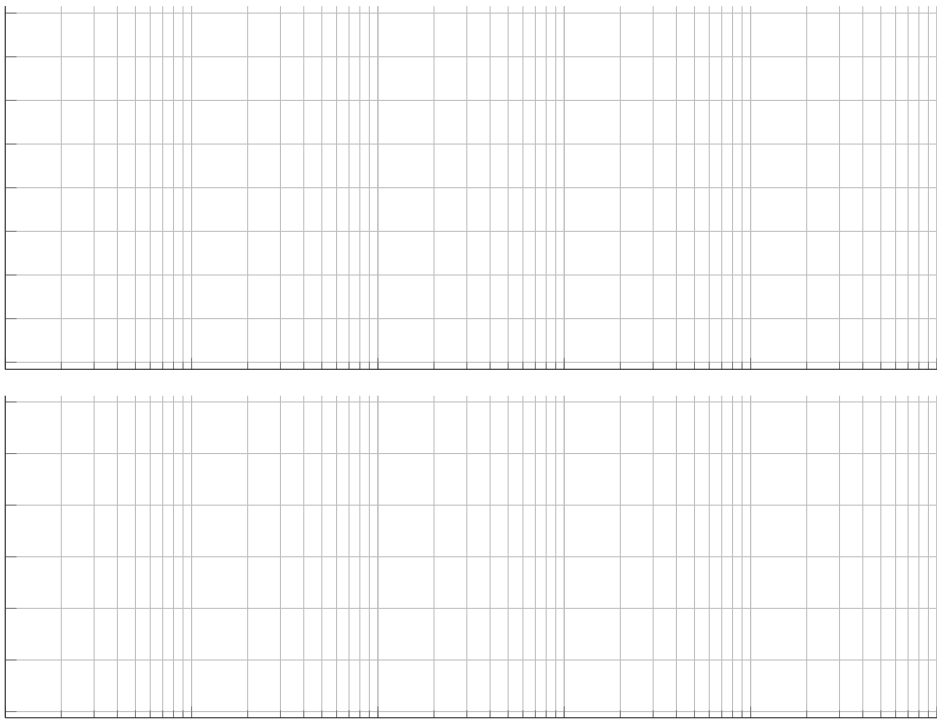
   (a) $L(s) = \dfrac{1}{s(s+1)(s+5)(s+10)}$

   (b) $L(s) = \dfrac{s+2}{s(s+1)(s+5)(s+10)}$

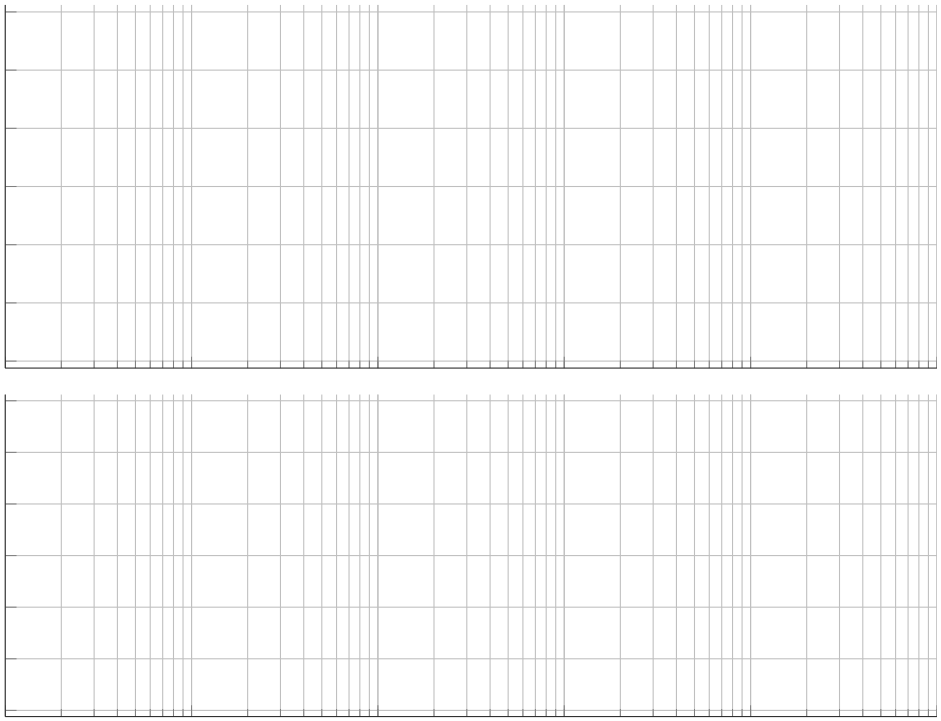
   (c) $L(s) = \dfrac{(s+2)(s+4)}{s(s+1)(s+5)(s+10)}$

   (d) $L(s) = \dfrac{(s+2)(s+6)}{s(s+1)(s+5)(s+10)}$

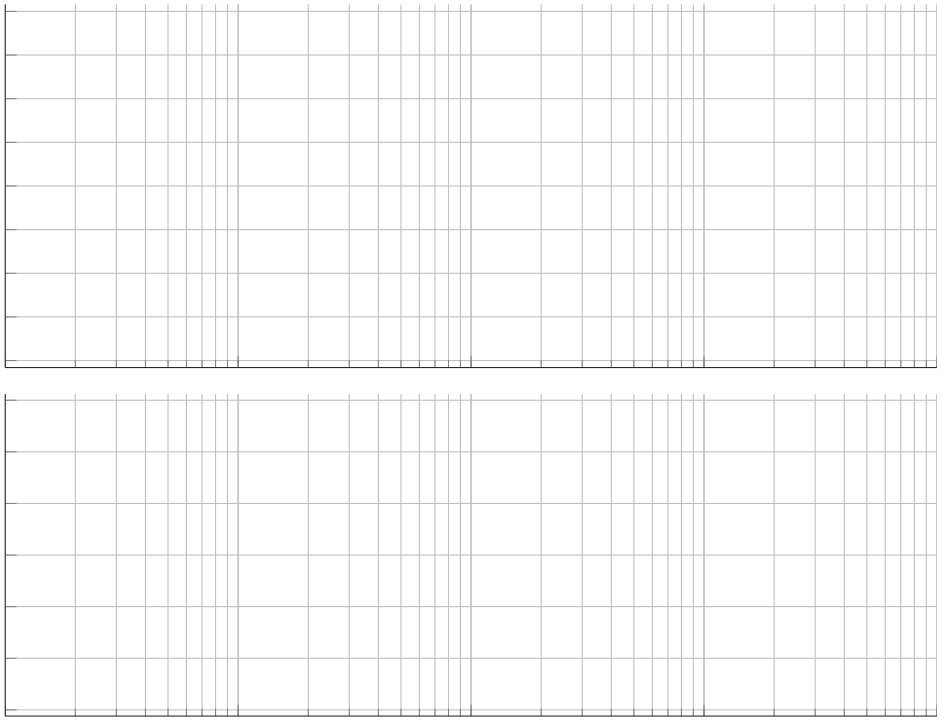
   (a)



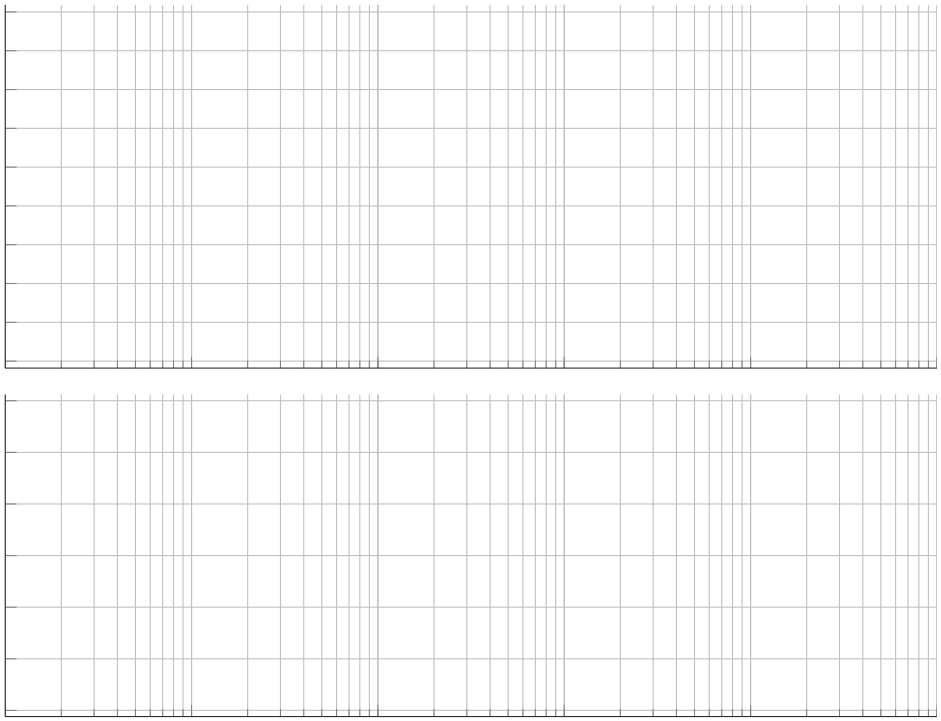
(b)



(c)



(d)



3. [FPE10, Aufgabe 6.5] Komplexe Pole und Nullstellen. Bestimmen / approximieren Sie den Wert des Amplitudengangs an den Eckfrequenzen der Terme zweiter Ordnung.

   (a) $L(s) = \dfrac{1}{s^2 + 3s + 10}$

   (b) $L(s) = \dfrac{1}{s(s^2 + 3s + 10)}$

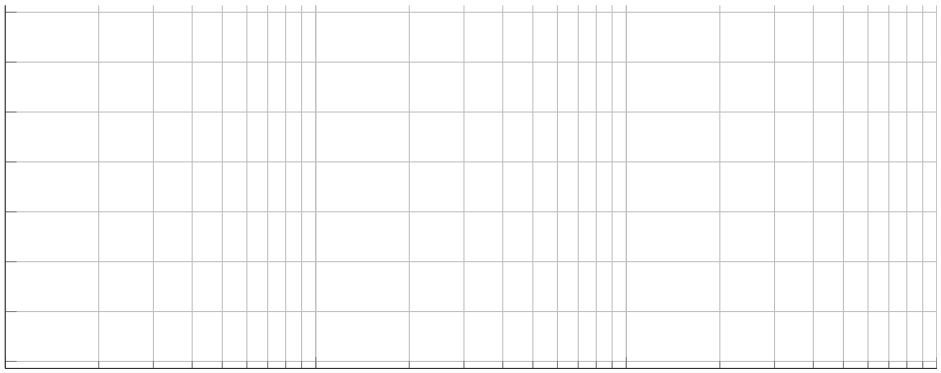
   (c) $L(s) = \dfrac{s^2 + 2s + 8}{s(s^2 + 2s + 10)}$

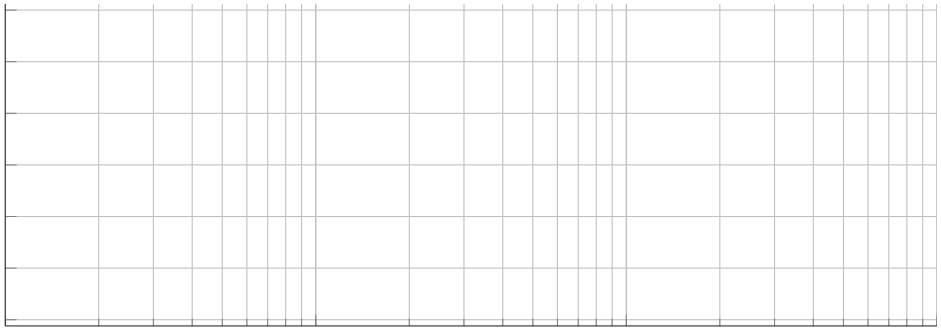
   (d) $L(s) = \dfrac{s^2 + 2s + 12}{s(s^2 + 2s + 10)}$

   (e) $L(s) = \dfrac{s^2 + 1}{s(s^2 + 4)}$

   (f) $L(s) = \dfrac{s^2 + 4}{s(s^2 + 1)}$

   (a)

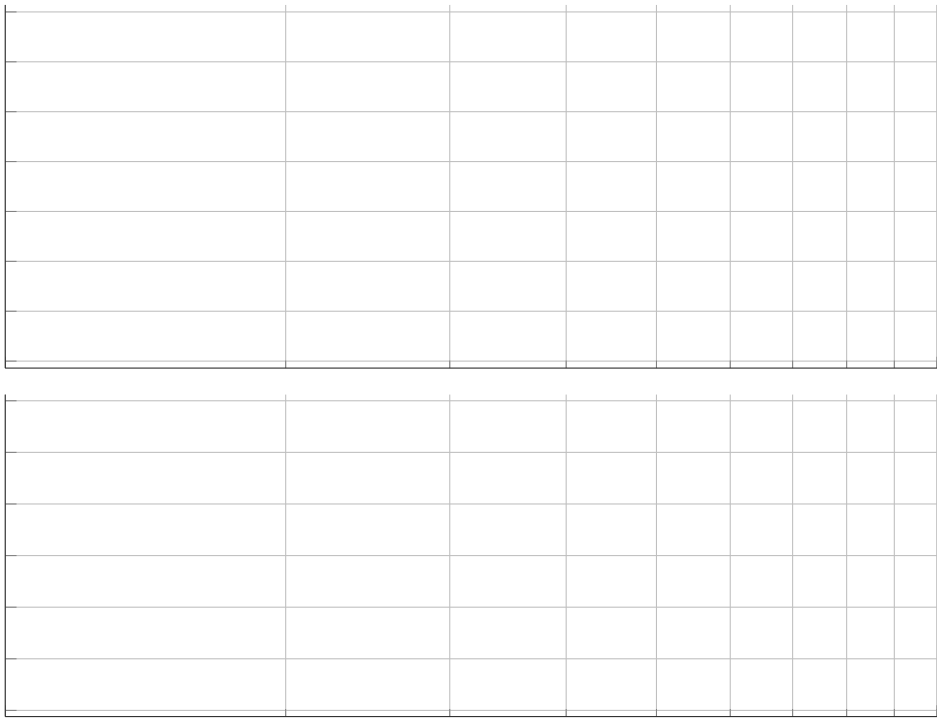




(b)

(c)

(d)



(e)

(f)

4. [FPE10, Aufgabe 6.6] Mehrfache Pole im Ursprung.

   (a) $L(s) = \dfrac{1}{s^2(s+8)}$

   (b) $L(s) = \dfrac{1}{s^3(s+8)}$

   (c) $L(s) = \dfrac{1}{s^4(s+8)}$

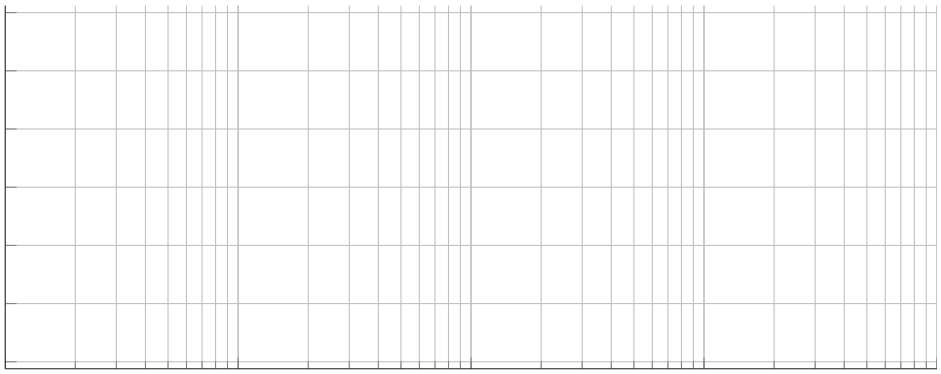
   (d) $L(s) = \dfrac{s+3}{s^2(s+8)}$

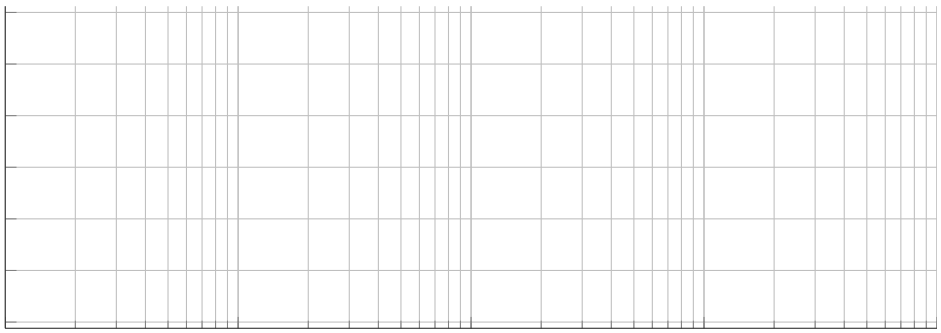
   (e) $L(s) = \dfrac{s+3}{s^3(s+4)}$

   (f) $L(s) = \dfrac{(s+1)^2}{s^3(s+4)}$

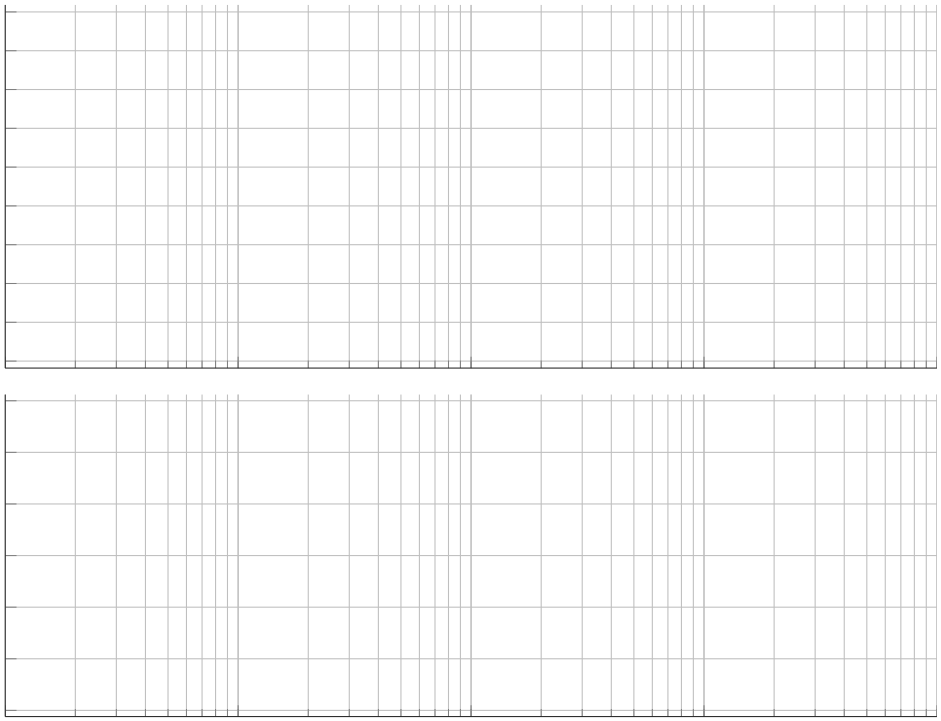
   (g) $L(s) = \dfrac{(s+1)^2}{s^3(s+10)^2}$

   (a)

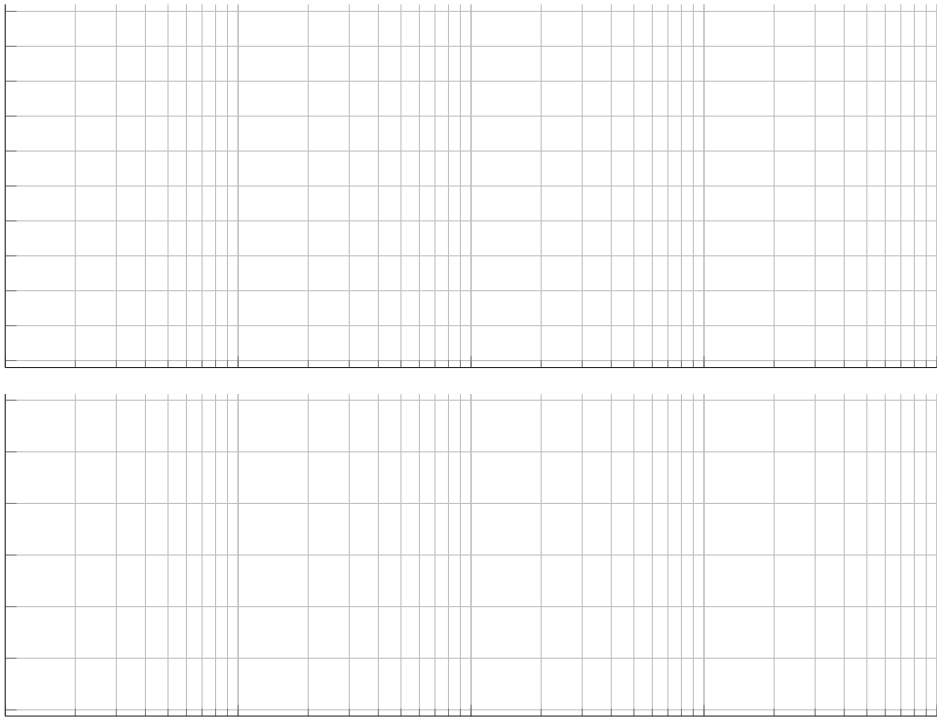




(b)



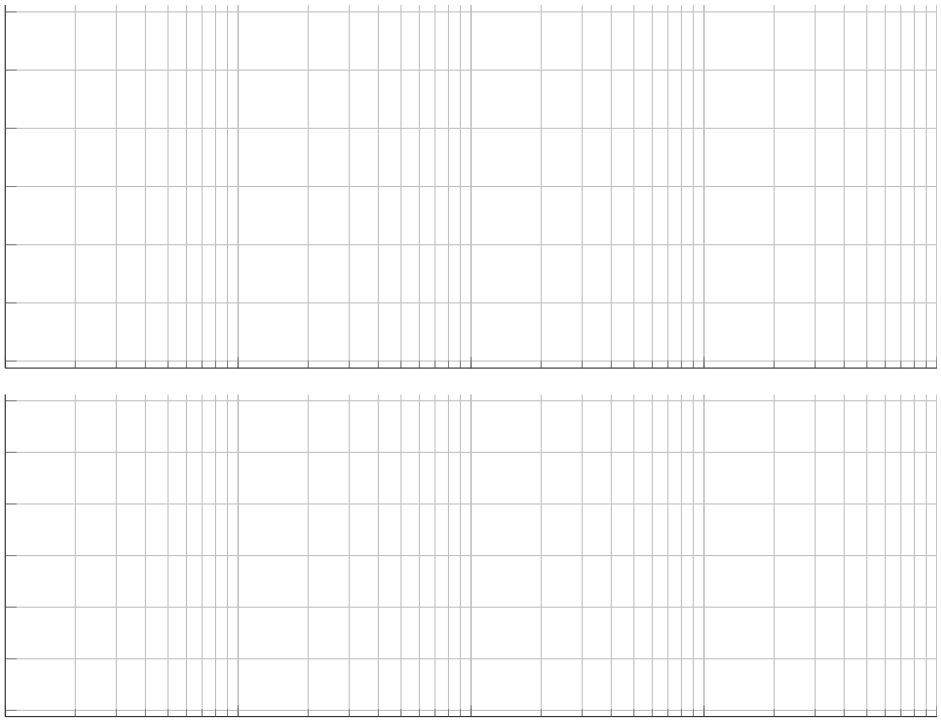
(c)



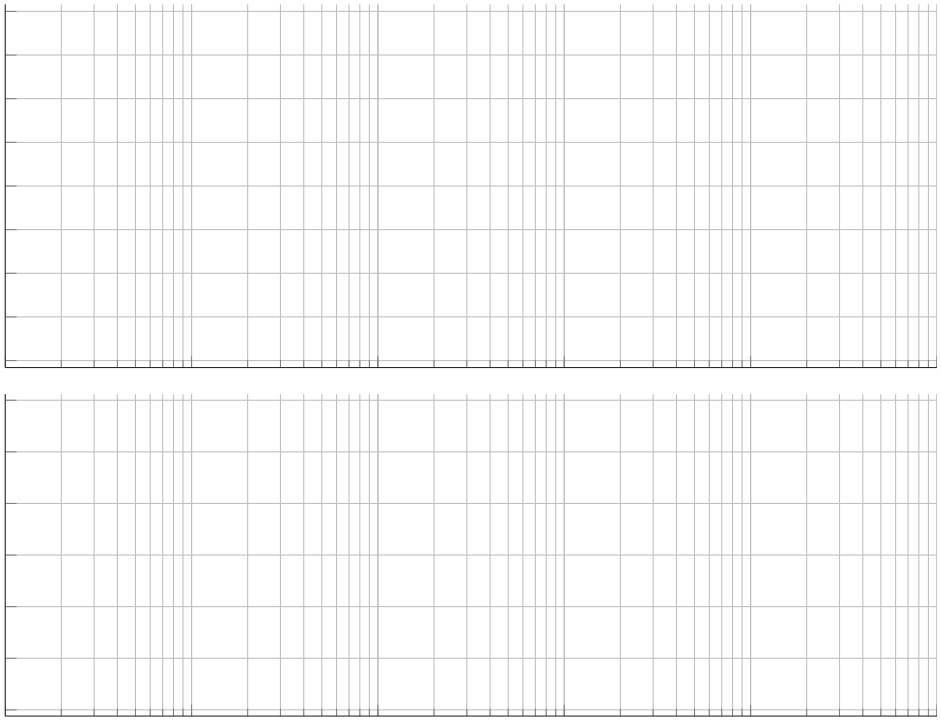
(d)

(e)

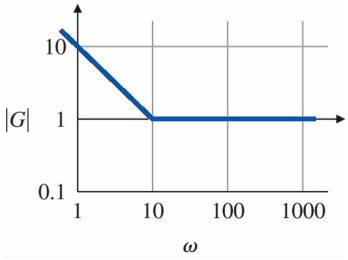
(f)



(g)



5. [FPE10, Aufgabe 6.9] Bestimmen sie die Übertragungsfunktion für folgendes asymptotisches Bodediagramm:



[FPE10, Figure 6.87]

Bestimmen Sie die Sprungantwort des Systems.

Aufgabe 3: Nyquist Stabilitätskriterium

1. [FPE10, Aufgabe 6.18] Skizzieren Sie den NyquistPlot anhand der Bodeplots der folgenden Systeme. Vergleichen Sie Ihr Ergebnis mit dem, das MATLAB mit dem Befehl `nyquist` erzeugt.
   (a) $KG(s) = \dfrac{K(s+2)}{s+10}$
   (b) $KG(s) = \dfrac{K}{(s+10)(s+2)^2}$
   (c) $KG(s) = \dfrac{K(s+10)(s+1)}{(s+100)(s+2)^2}$
   (d) Schätzen Sie mit Hilfe Ihrer Plots die Bereiche von K, für die die System stabil sind.

Literatur

[FPE10] Gene F. Franklin, J. David Powel und Abbas Emami-Naeini. *Feedback Control of Dynamic Systems*. 6th international edition. Pearson Prentice Hall, 2010.