

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) $L(s) = \frac{2000}{s(s+200)}$

(b) $L(s) = \frac{100}{s(0.1s+1)(0.5s+1)}$

(c) $L(s) = \frac{1}{s(s+1)(0.02s+1)}$

(d) $L(s) = \frac{1}{(s+1)^2(s^2+2s+4)}$

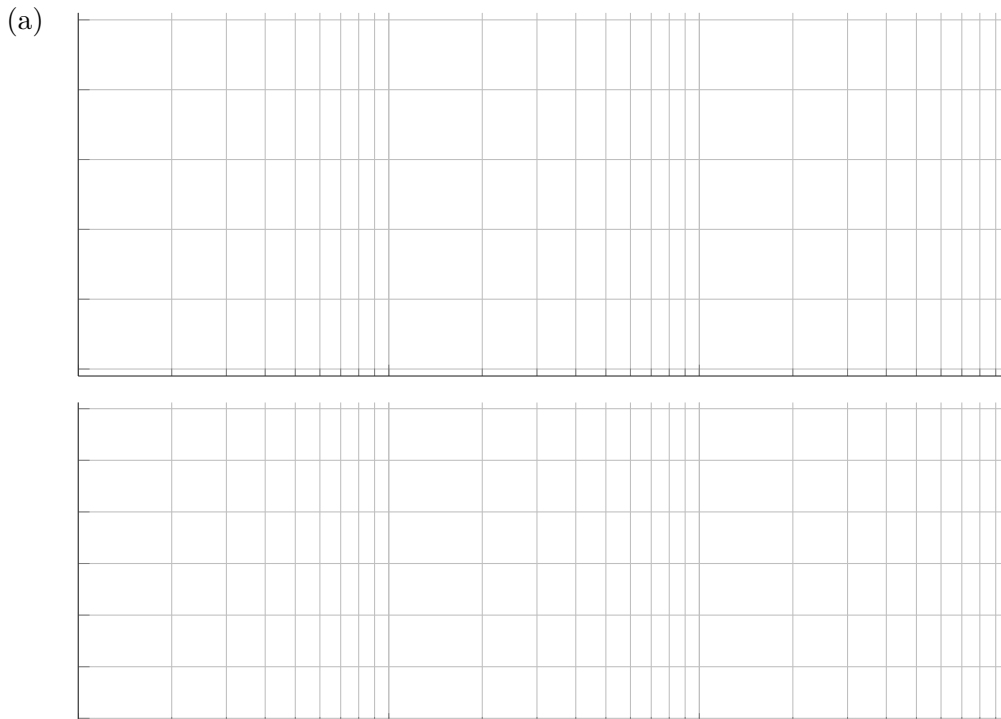
(e) $L(s) = \frac{10(s+4)}{s(s+1)(s^2+2s+5)}$

(f) $L(s) = \frac{1000(s+0.1)}{s(s+1)(s^2+8s+64)}$

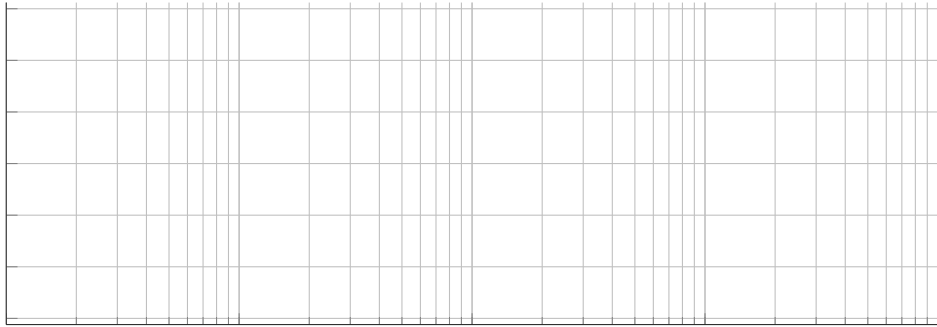
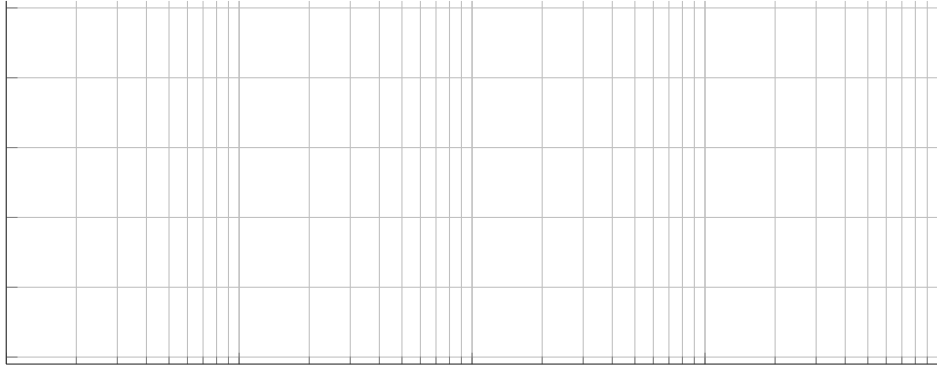
(g) $L(s) = \frac{(s+5)(s+3)}{s(s+1)(s^2+s+4)}$

(h) $L(s) = \frac{4s(s+10)}{(s+100)(4s^2+5s+4)}$

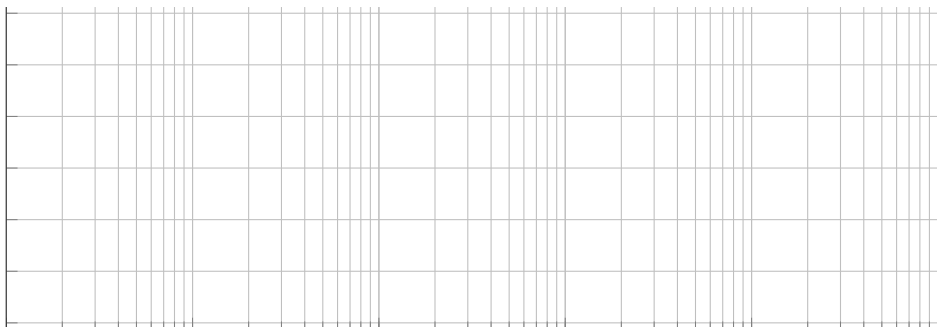
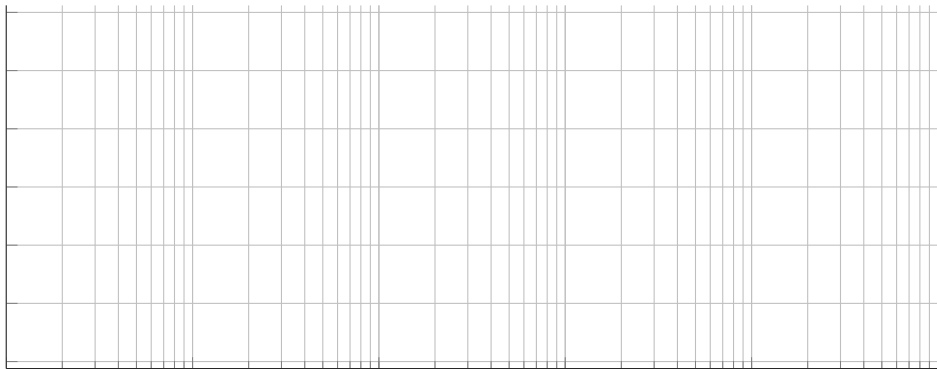
(i) $L(s) = \frac{s}{(s+1)(s+10)(s^2+2s+2500)}$



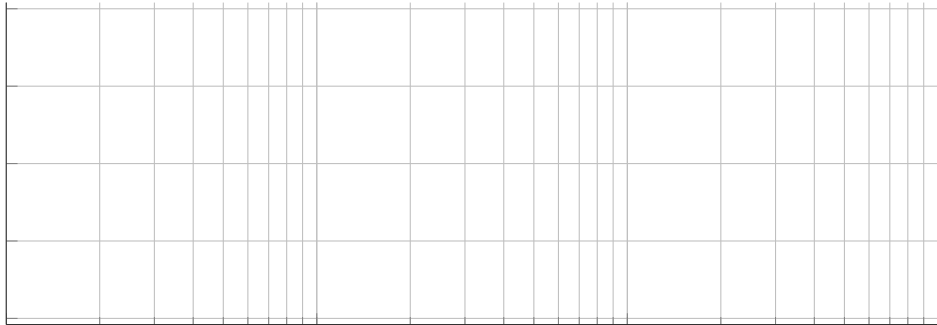
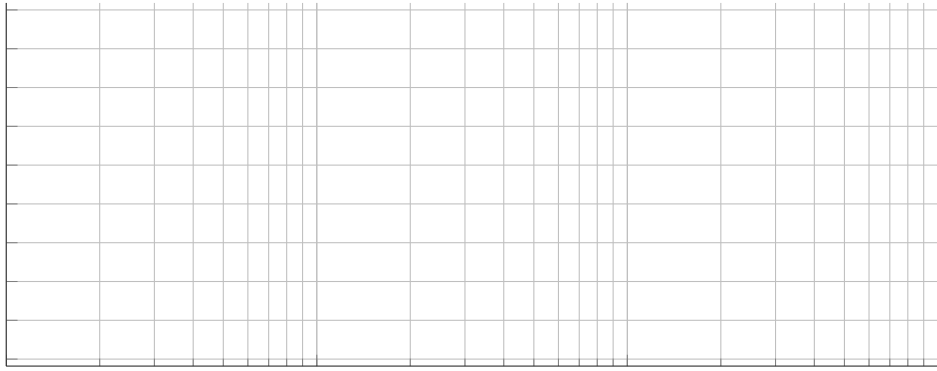
(b)



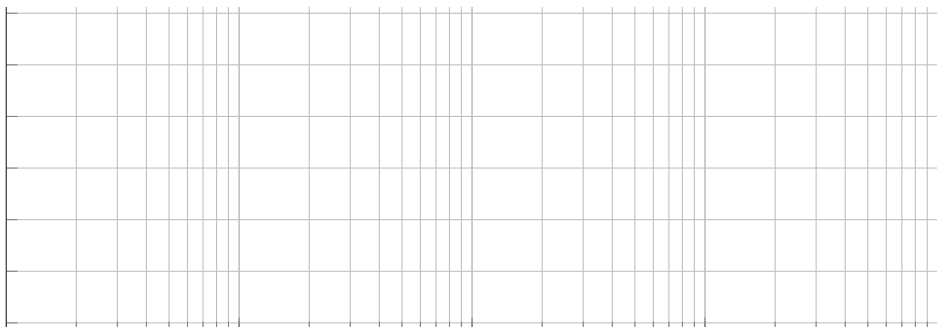
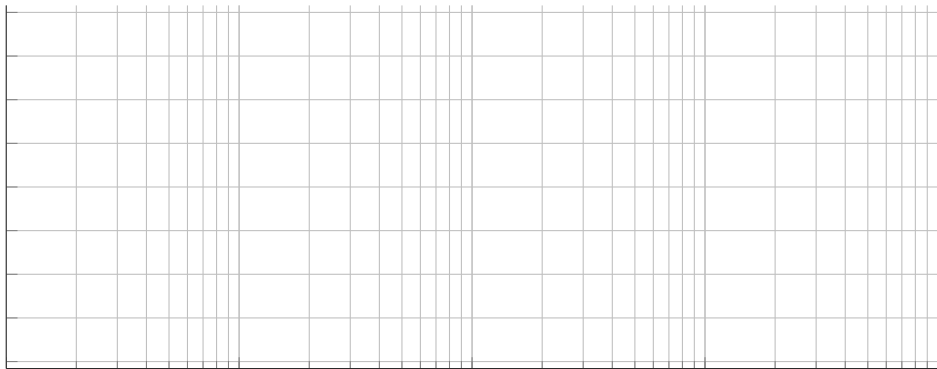
(c)



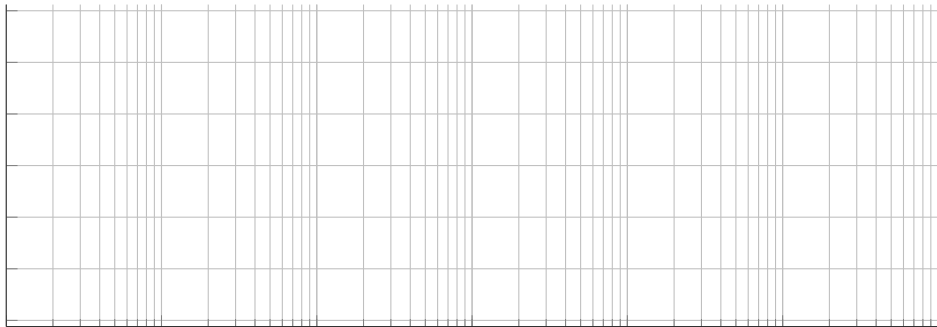
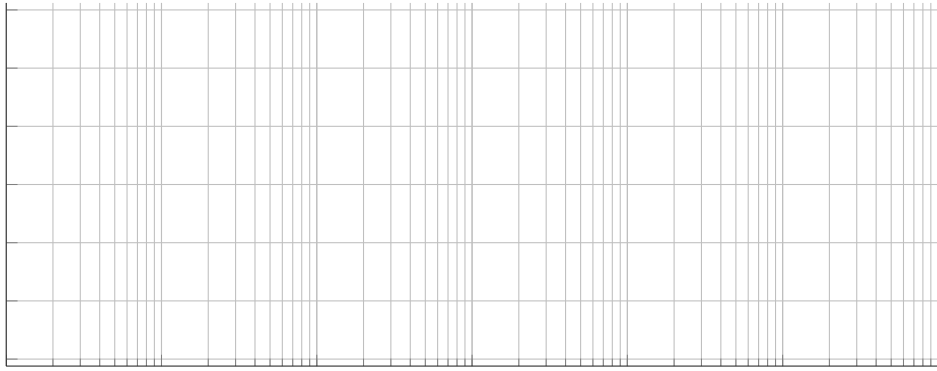
(d)



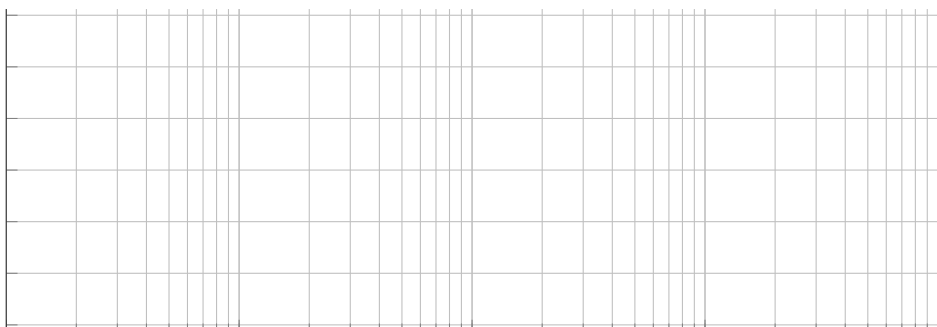
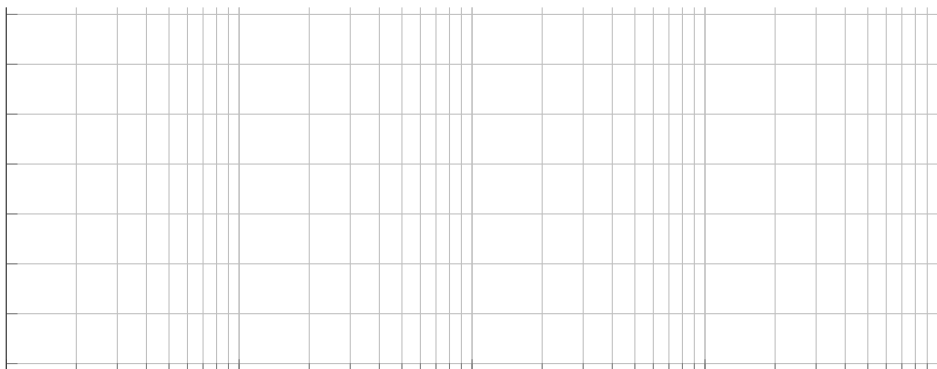
(e)



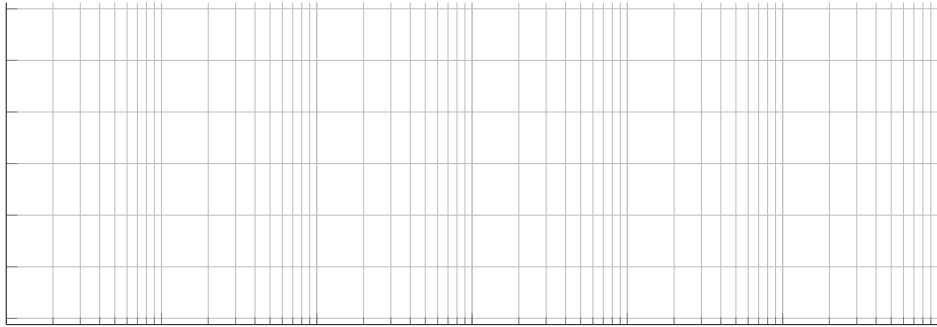
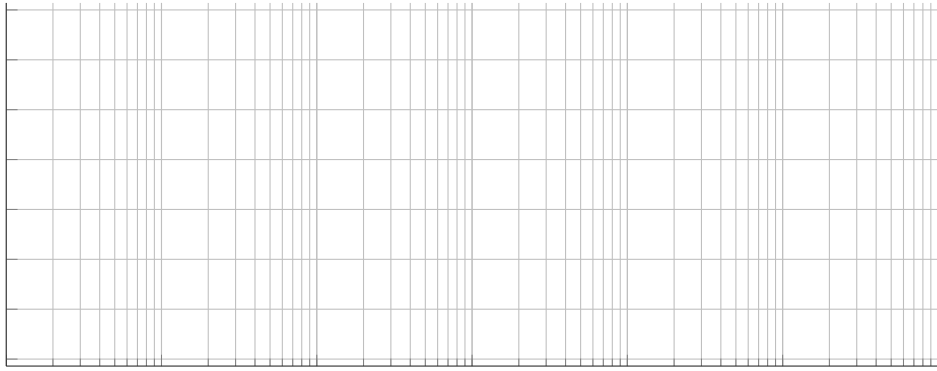
(f)



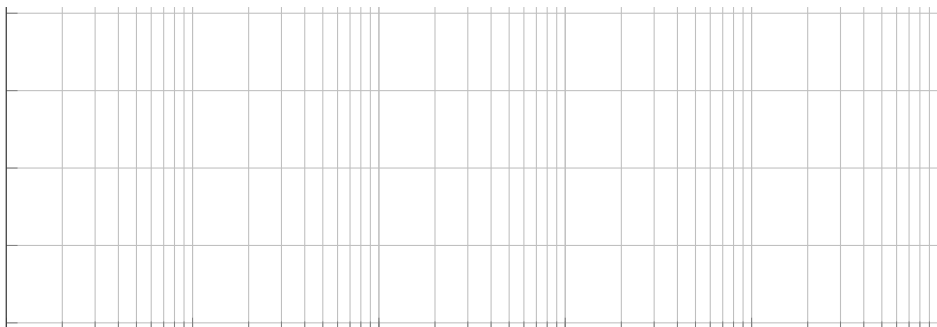
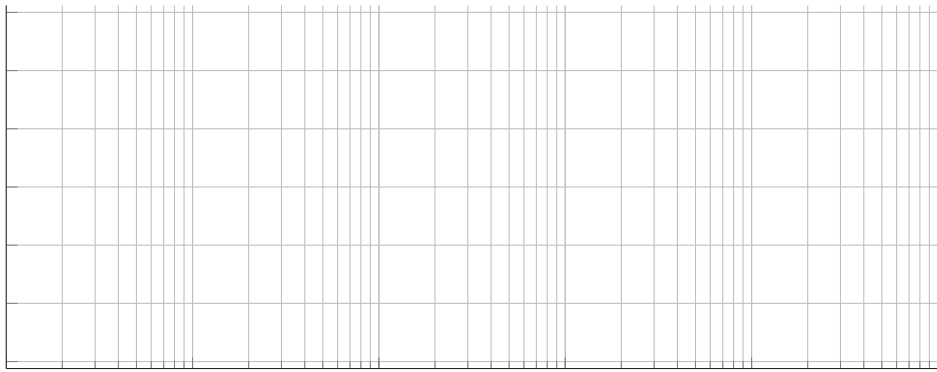
(g)



(h)



(i)



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

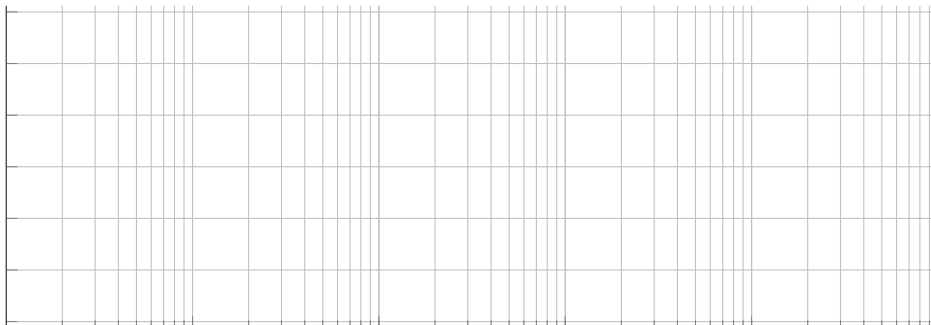
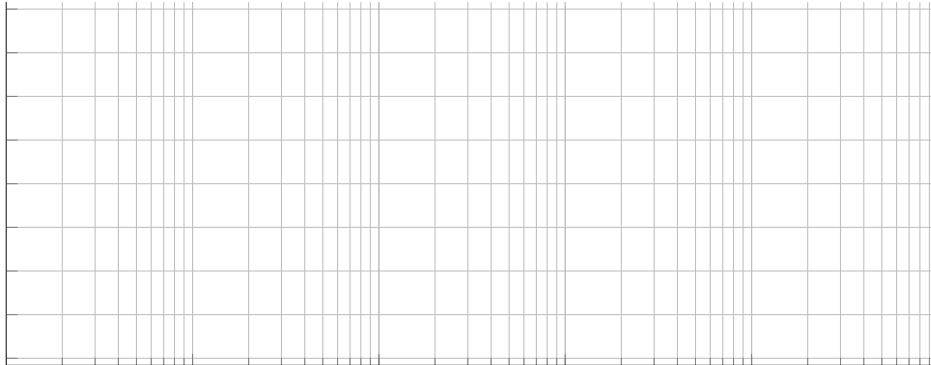
$$(a) L(s) = \frac{1}{s(s+1)(s+5)(s+10)}$$

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

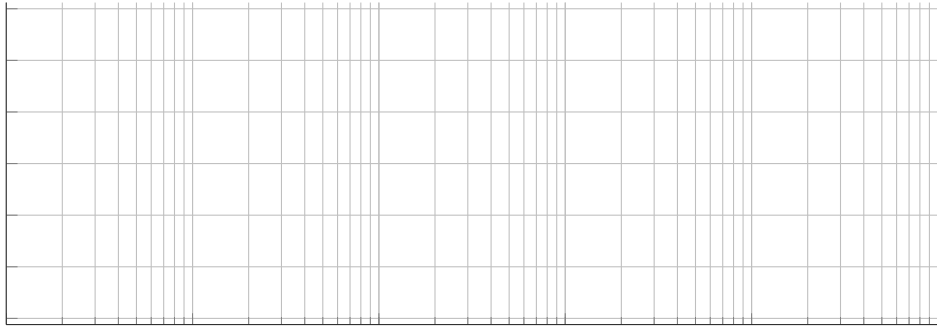
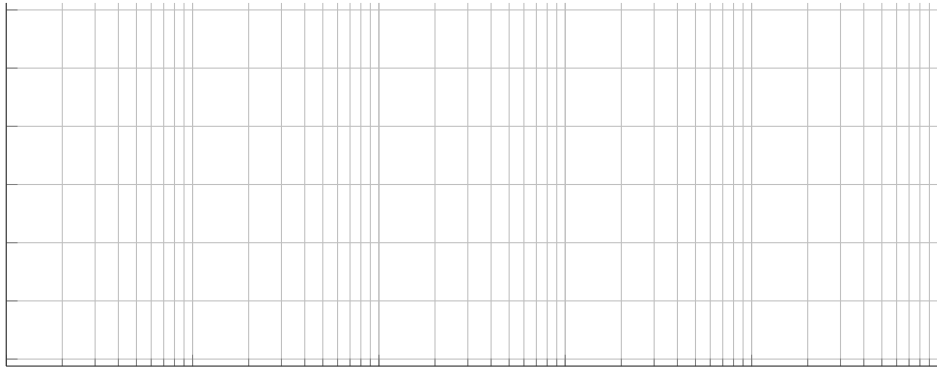
$$(c) L(s) = \frac{(s+2)(s+4)}{s(s+1)(s+5)(s+10)}$$

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

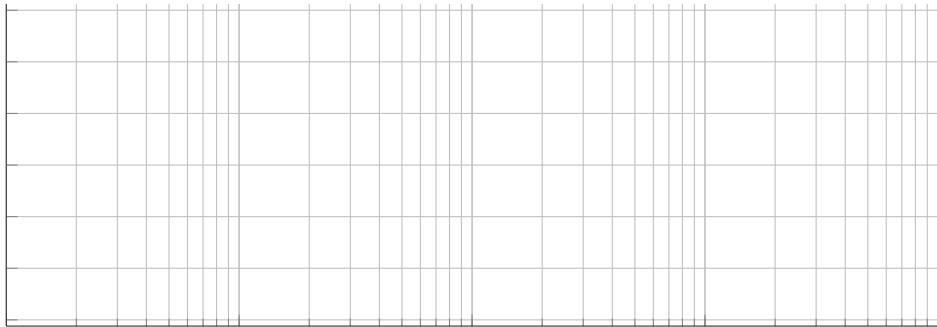
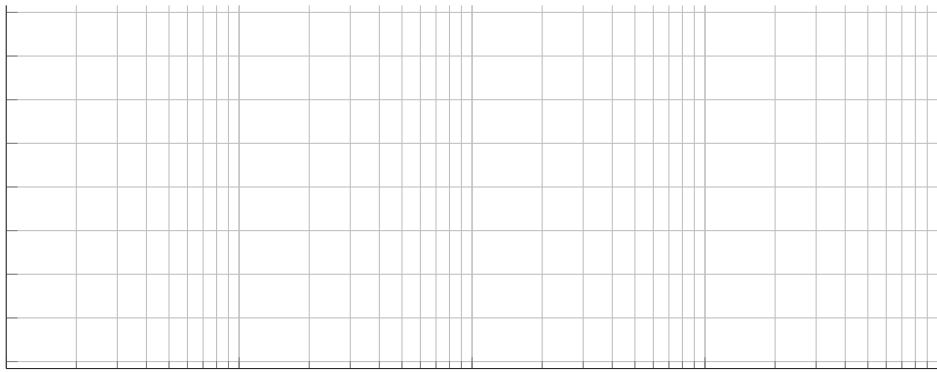
(a)



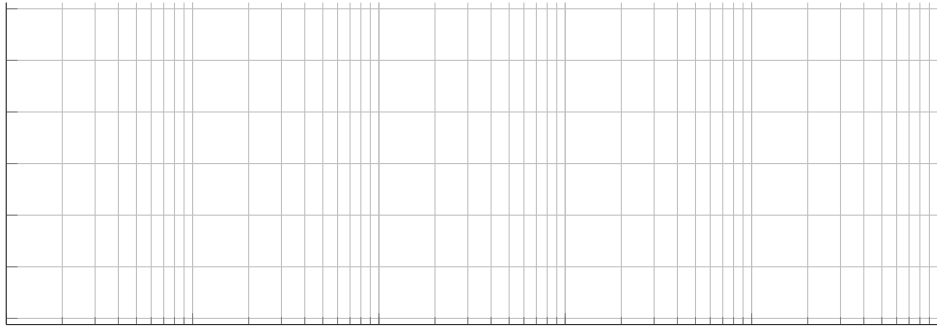
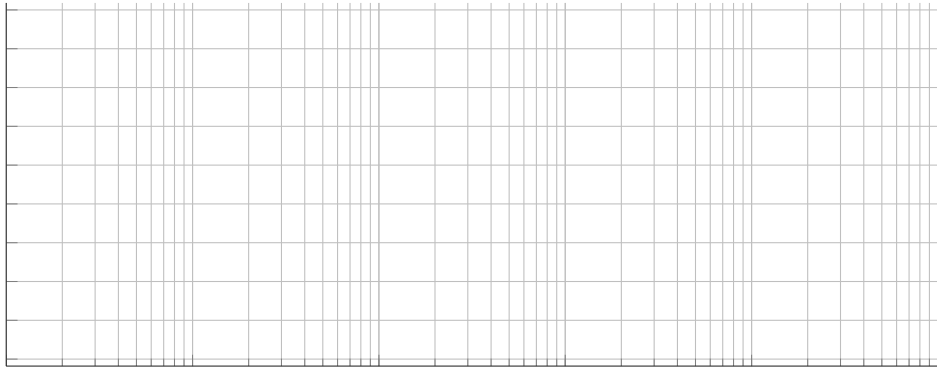
(b)



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

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

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

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

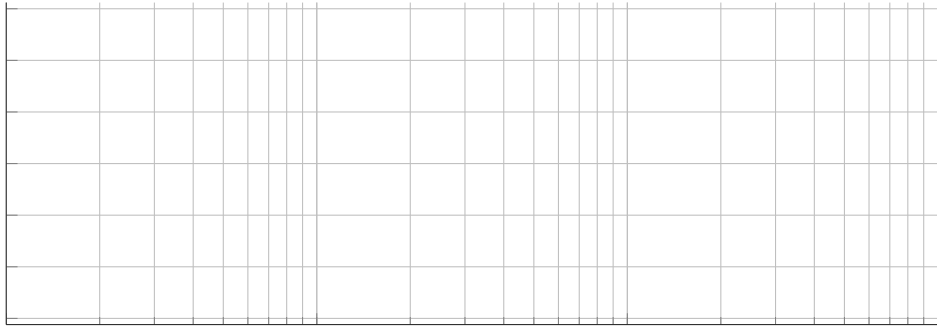
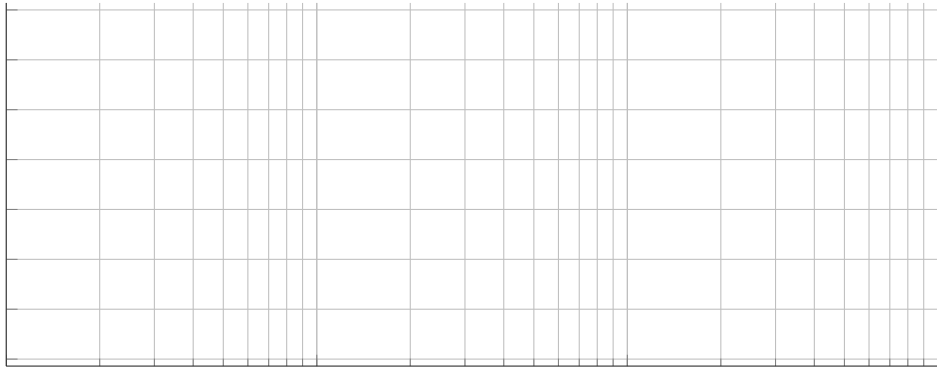
(e) $L(s) = \frac{s^2 + 1}{s(s^2 + 4)}$

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

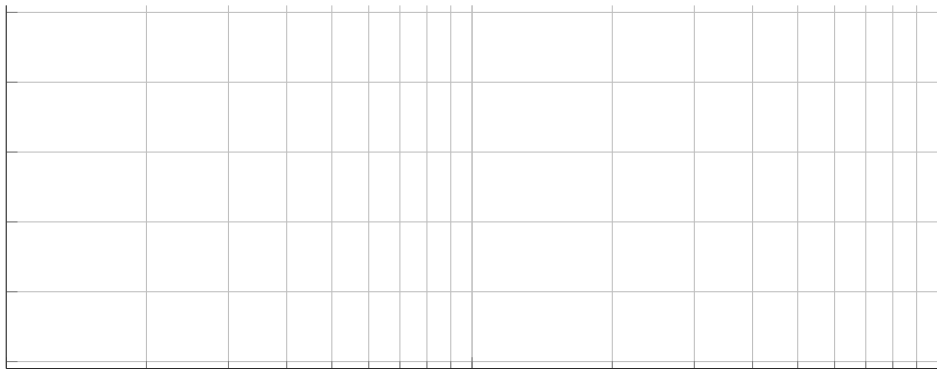
(a)

The form contains two identical empty grid areas for calculations. Each grid is approximately 20 columns wide and 10 rows high. The label '(a)' is positioned to the left of the top grid.

(b)



(c)



(d)

(e)

(f)

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

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

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

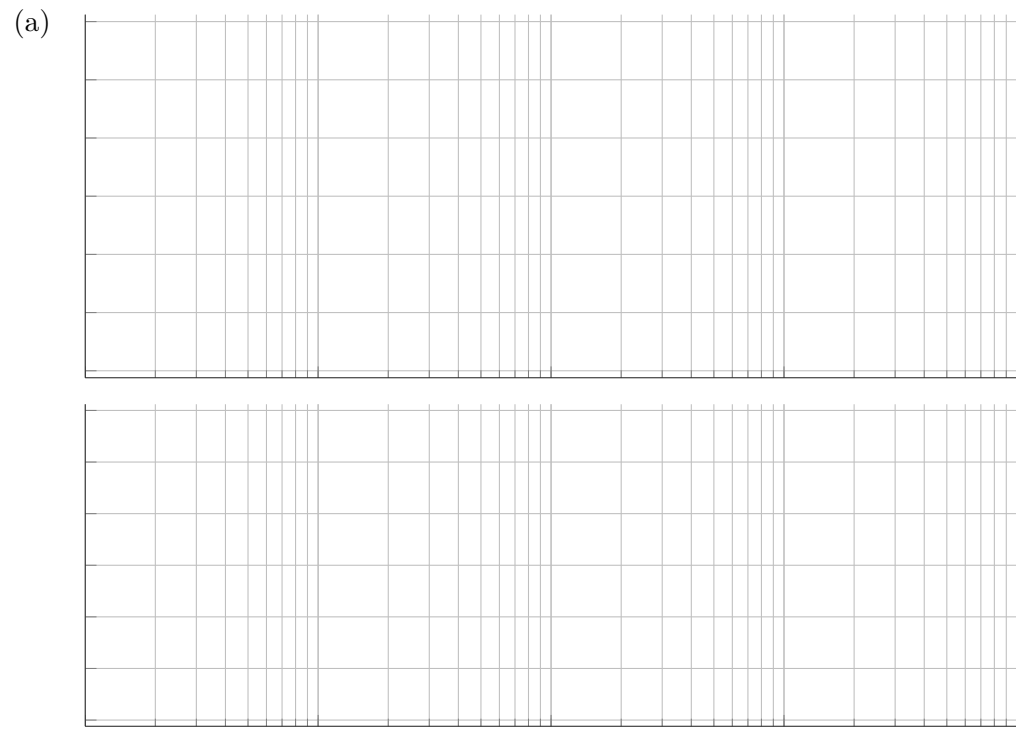
(c) $L(s) = \frac{1}{s^4(s+8)}$

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

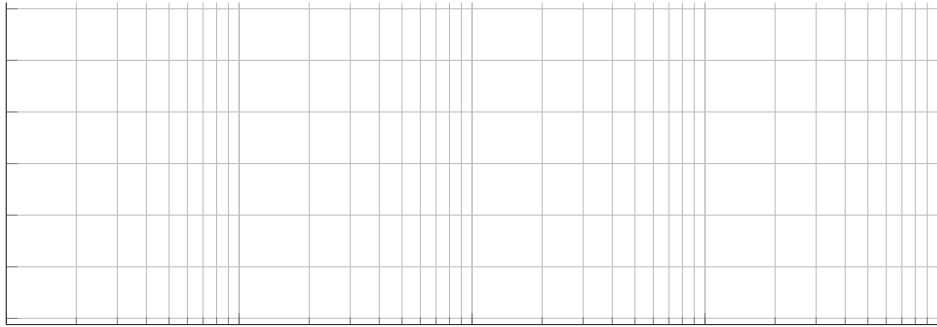
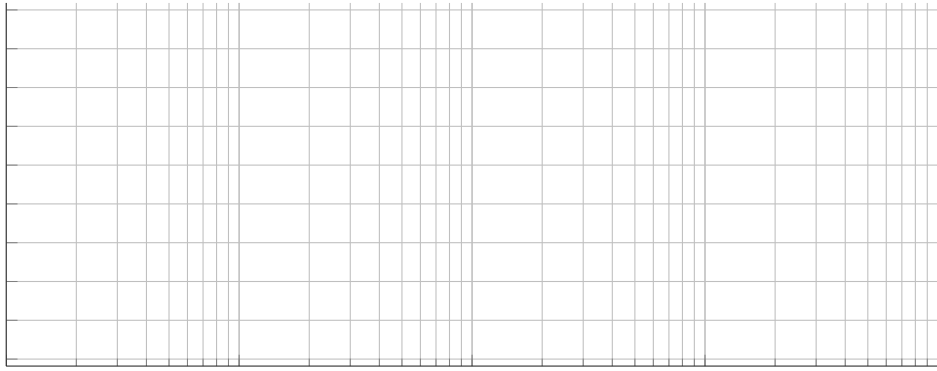
(e) $L(s) = \frac{s+3}{s^3(s+4)}$

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

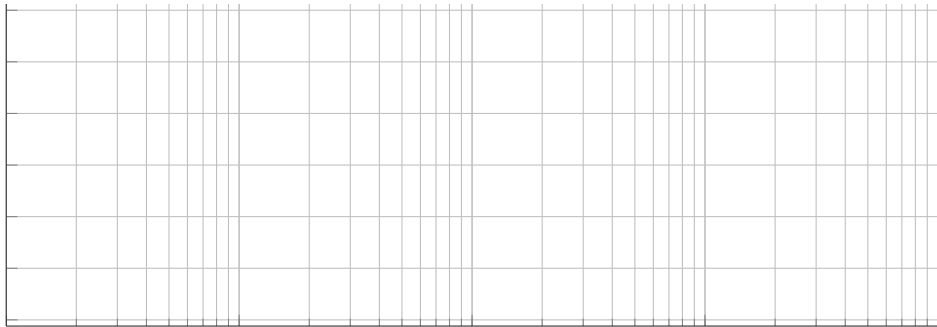
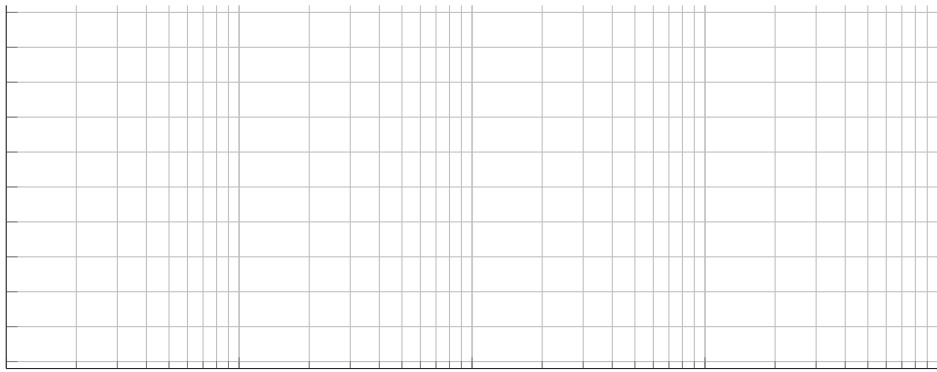
(g) $L(s) = \frac{(s+1)^2}{s^3(s+10)^2}$



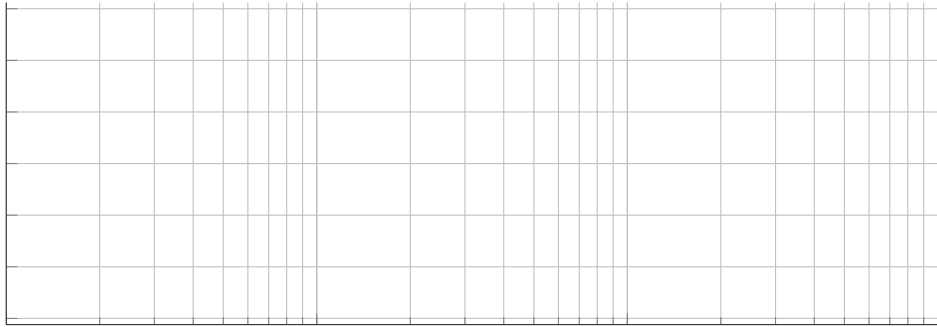
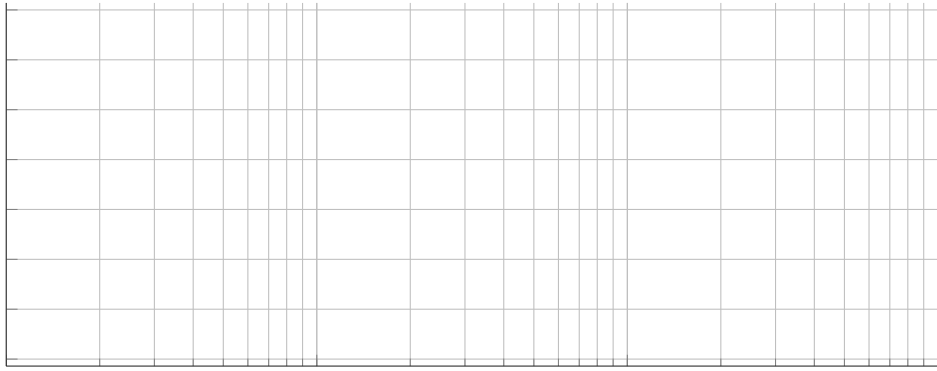
(b)



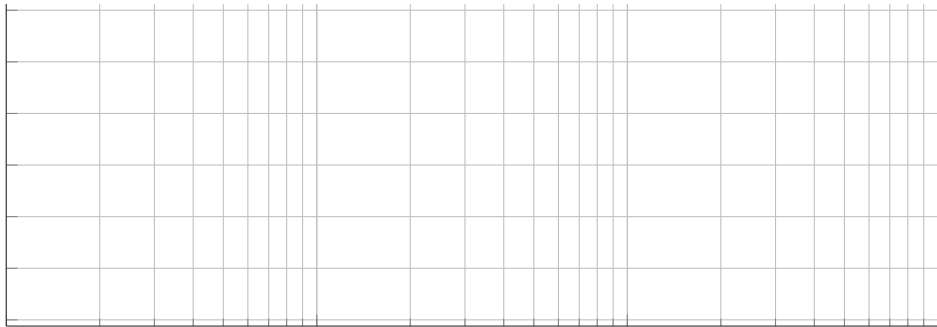
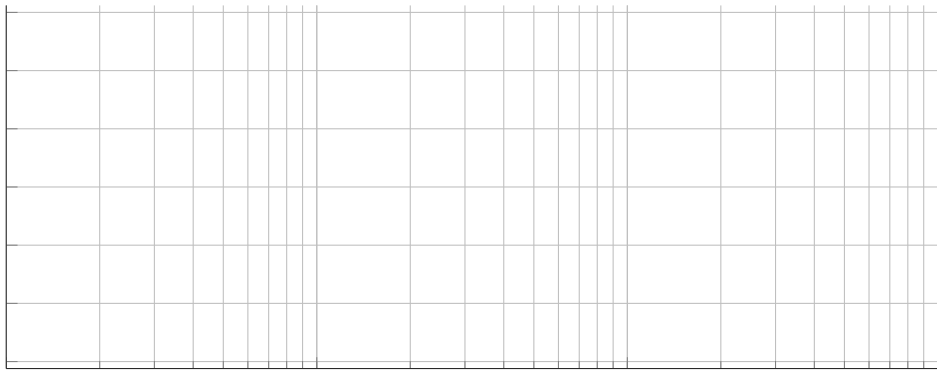
(c)



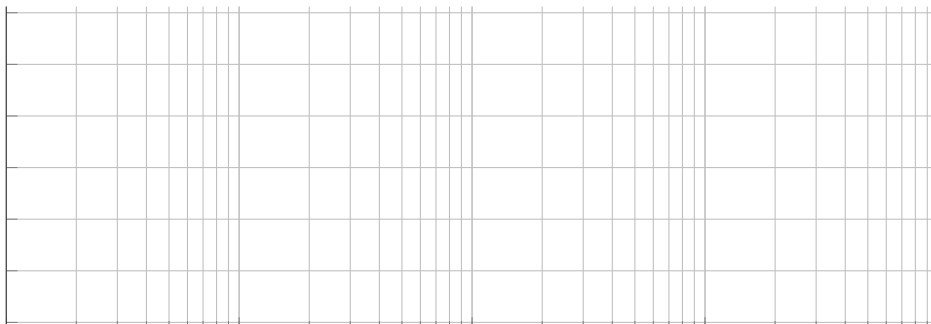
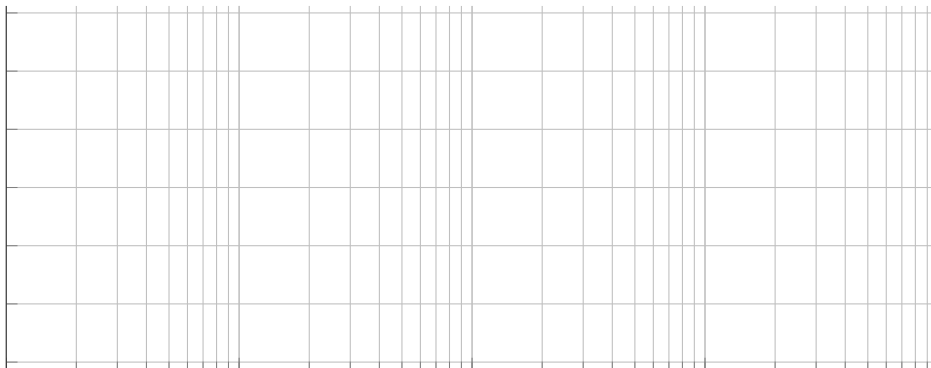
(d)



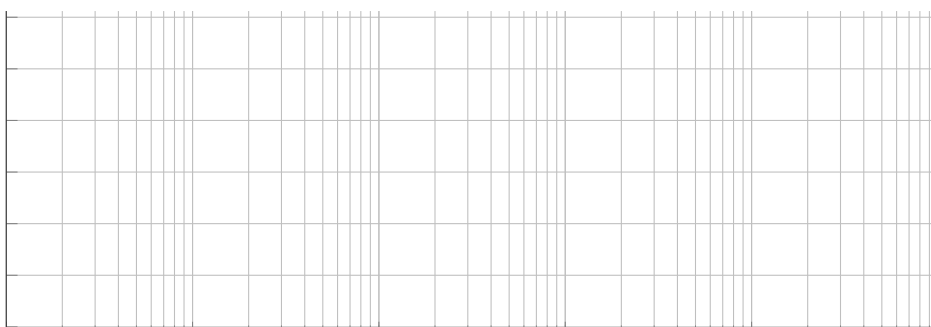
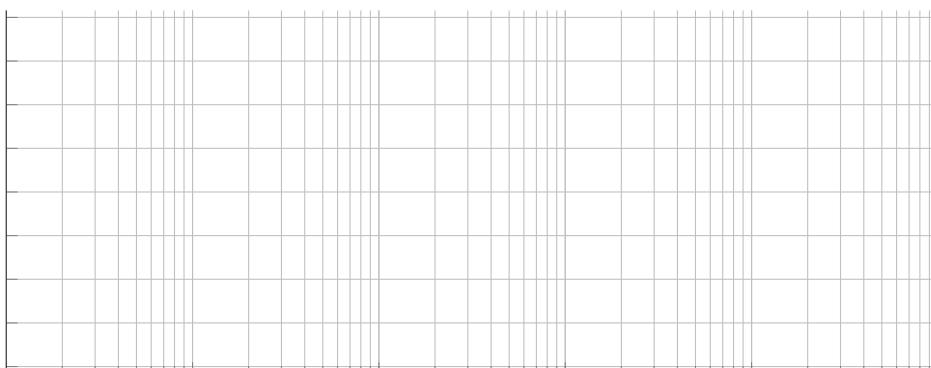
(e)



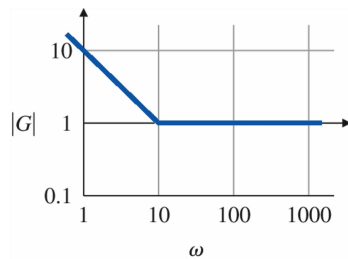
(f)



(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) $KG(s) = \frac{K(s+2)}{s+10}$

(b) $KG(s) = \frac{K}{(s+10)(s+2)^2}$

(c) $KG(s) = \frac{K(s+10)(s+1)}{(s+100)(s+2)^2}$

- (d) Schätzen Sie mit Hilfe Ihrer Plots die Bereiche von K , für die die System stabil sind.

Literatur

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