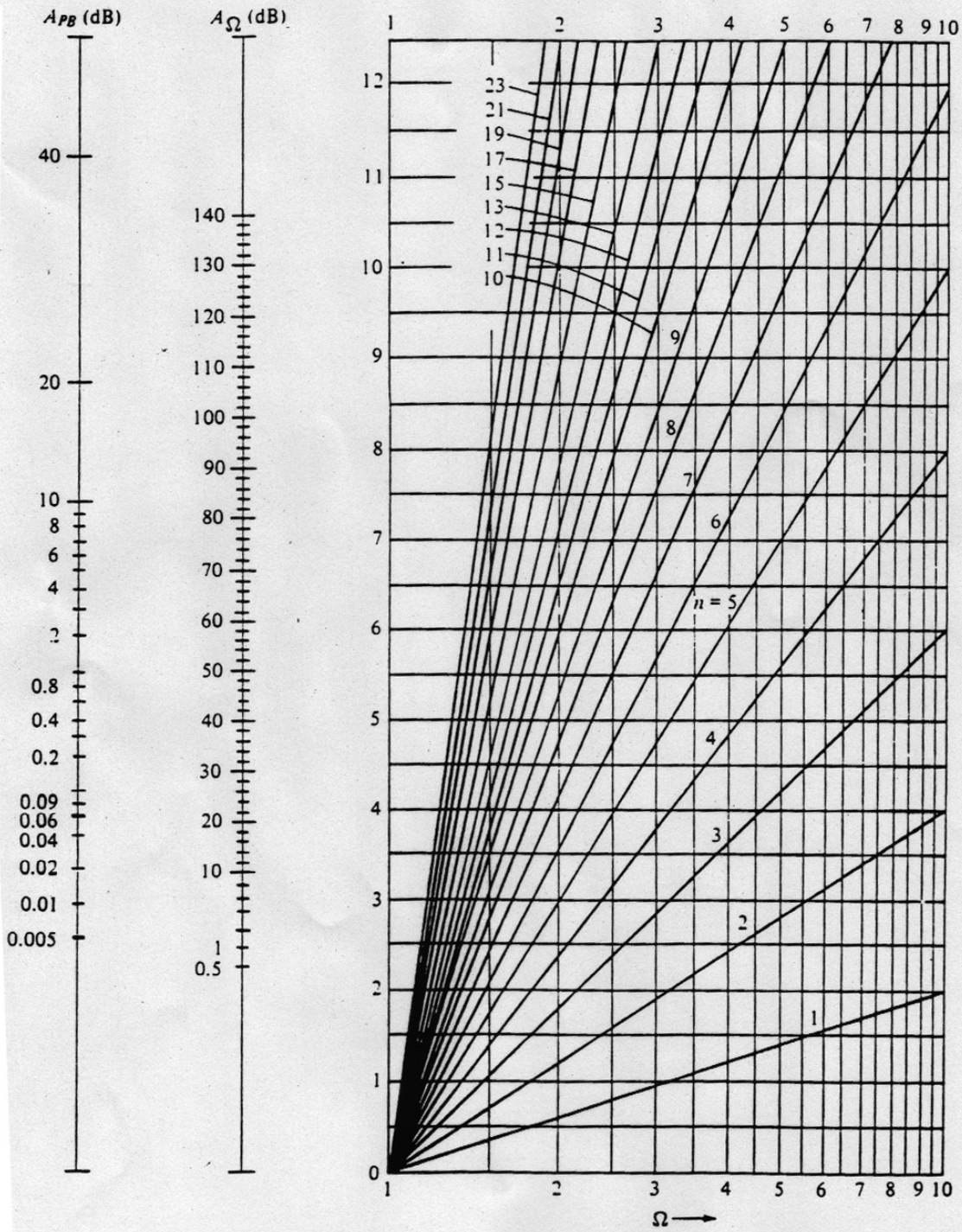


# Butterworth Chart



A nomograph for determining the order of a maximally flat magnitude function.

# Chebyshev chart

## 2.2 MAGNITUDE APPROXIMATION—THE EQUAL-RIPPLE CHARACTERISTIC 39

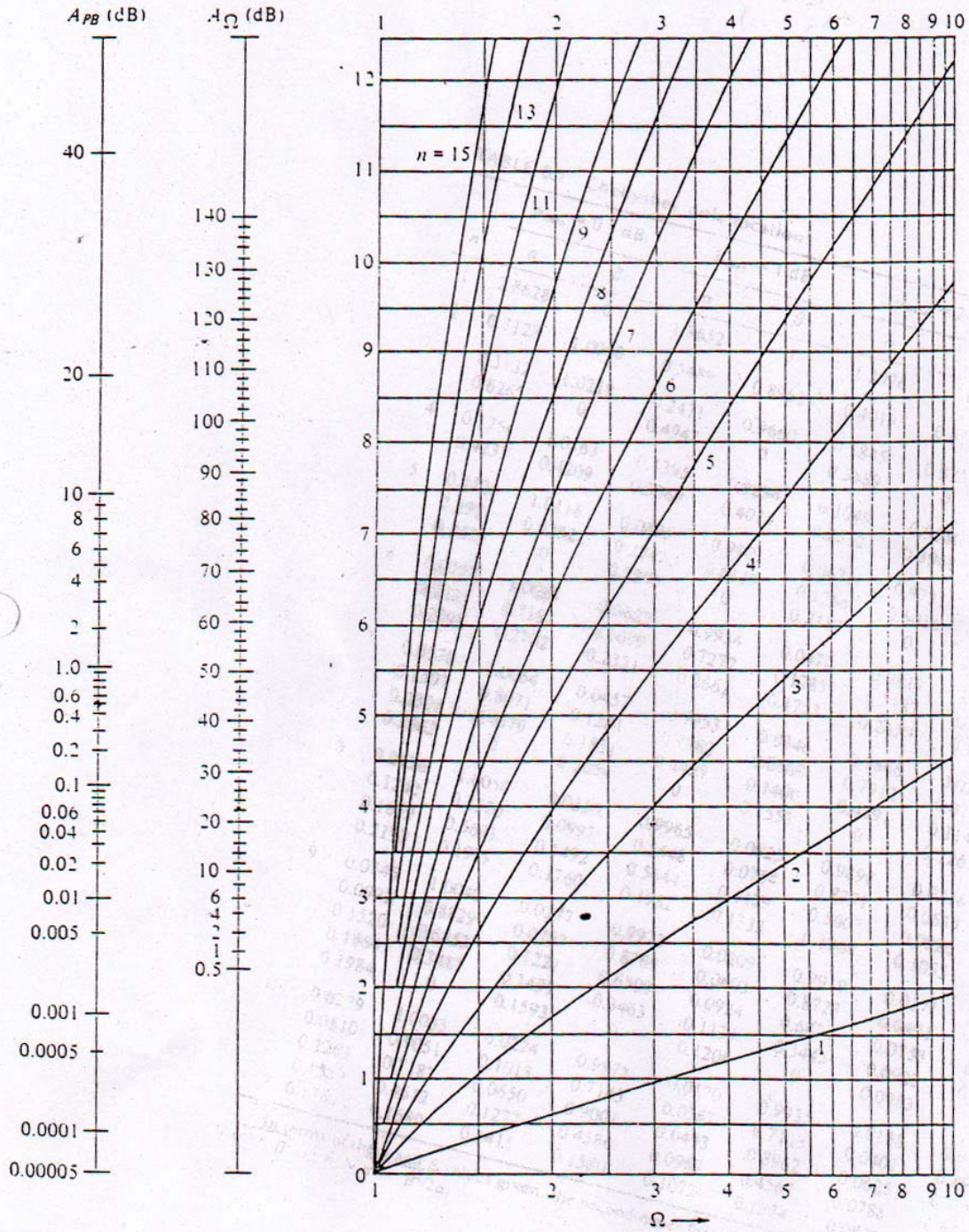


Figure 2.2-5 A nomograph for determining the order of an equal-ripple magnitude function.

# Elliptic chart

## 2.3 MAGNITUDE APPROXIMATION—THE ELLIPTIC CHARACTERISTIC 61

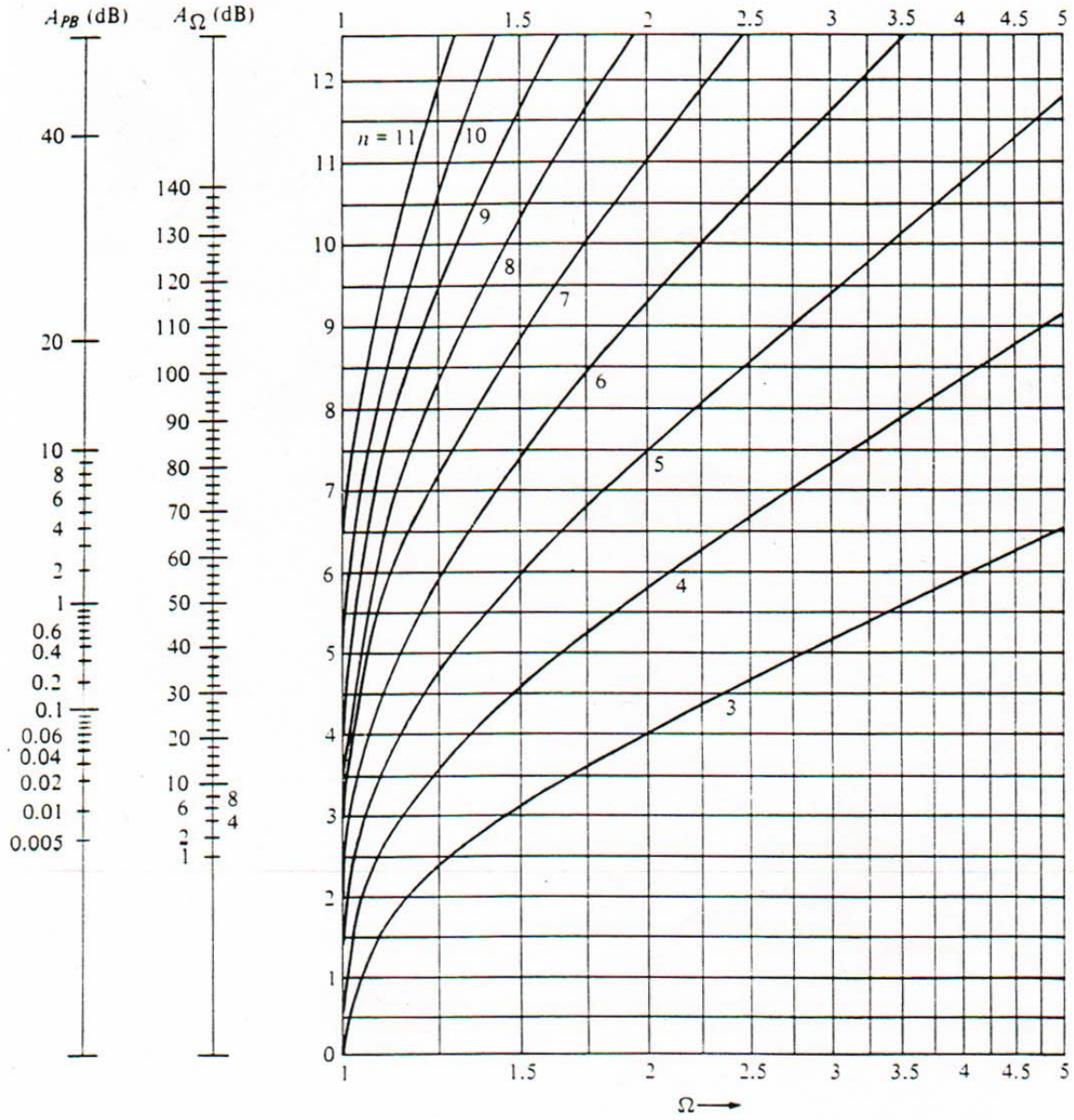
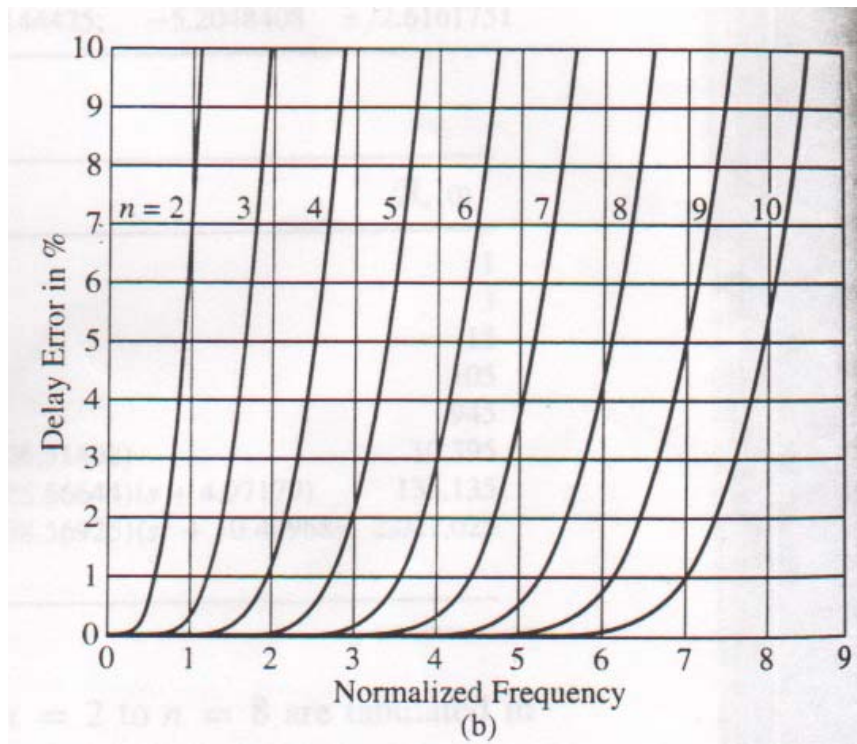
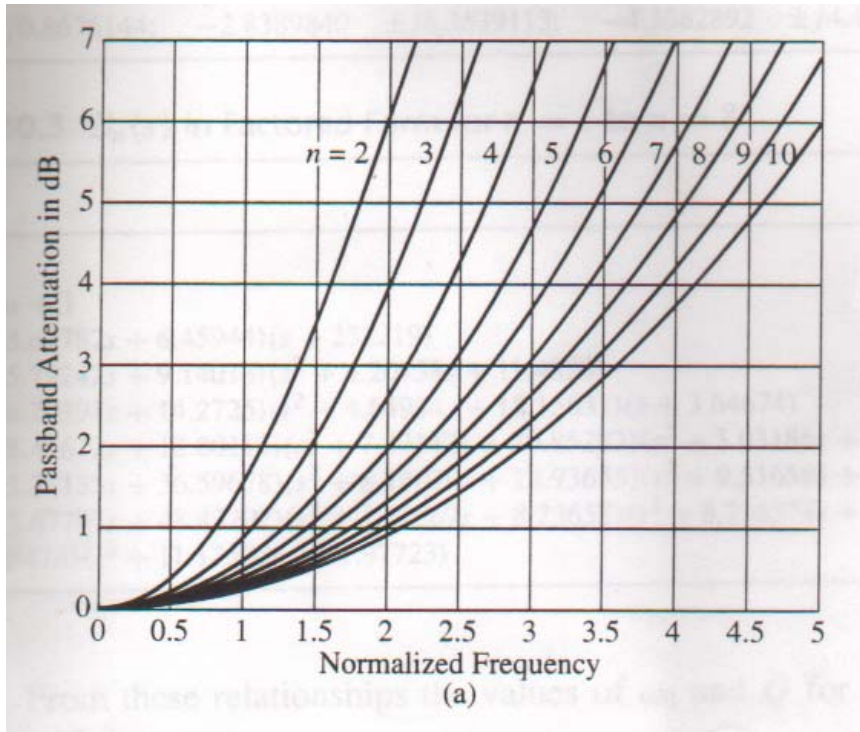


Figure 2.3-3 A nomograph for determining the order of an elliptic magnitude function.

# Bessel-Thomson chart



# Bessel-Thomson Tables

## Bessel Polynomials

**TABLE 10.2** Roots of  $\mathcal{B}_n(s) = 0$  for  $n = 1$  to  $n = 8$  [Poles of  $T_n(s)$  for Bessel-Thomson Response]

$n$	Roots
1	-1.0000000
2	-1.5000000 ± j0.8660254
3	-2.3221854; -1.8389073 ± j1.7543810
4	-2.8962106 ± j0.8672341; -2.1037894 ± j2.6574180
5	-3.6467386; -3.3519564 ± j1.7426614; -2.3246743 ± j3.5710229
6	-4.2483594 ± j0.8675097; -3.7357084 ± j2.6262723; -2.5159322 ± j4.4926730
7	-4.9717869; -4.7582905 ± j1.7392861; -4.0701392 ± j3.5171740; -2.6856769 ± j5.4206941
8	-5.5878860 ± j0.8676144; -2.8389840 ± j6.3539113; -4.3682892 ± j4.4144425; -5.2048408 ± j2.6161751

**TABLE 10.3**  $\mathcal{B}_n(s)$  in Factored Form for  $n = 1$  to  $n = 8$

$n$	$\mathcal{B}_n(s)$	$\mathcal{B}_n(0)$
1	$s + 1$	1
2	$s^2 + 3s + 3$	3
3	$(s^2 + 3.67782s + 6.45944)(s + 232219)$	15
4	$(s^2 + 5.79242s + 9.14013)(s^2 + 4.20758s + 11.4878)$	105
5	$(s^2 + 6.70391s + 14.2725)(s^2 + 4.64934s + 18.15631)(s + 3.64674)$	945
6	$(s^2 + 8.49672s + 18.80113)(s^2 + 7.47142s + 20.85282)(s^2 + 5.03186s + 26.51402)$	10,395
7	$(s^2 + 5.37135s + 36.59678)(s^2 + 8.14029s + 28.93655)(s^2 + 9.51658s + 25.66644)(s + 4.97179)$	135,135
8	$(s^2 + 5.67797s + 48.43202)(s^2 + 1.22567s + 8.73658)(s^2 + 8.736578s + 38.56925)(s^2 + 10.40968s + 33.93474)(s^2 + 11.17577s + 31.97723)$	2,027,025

**TABLE 10.4** Poles of  $T_n(s)$  in Terms of  $Q$ ,  $\omega_0$ , and  $\sigma$

$n$	$\omega_0; Q$ Are Ordered Pairs; $-\sigma$ Is One Entry	$\mathcal{B}_n(0)$
2	1.732; 0.577	3
3	2.542; 0.691      2.322	15
4	3.023; 0.522      3.389; 0.806	105
5	3.778; 0.564      4.261; 0.916      3.647	945
6	4.336; 0.510      4.566; 0.611      5.149; 1.023	10,395
7	5.066; 0.532      5.379; 0.661      6.050; 1.126      4.971	135,135
8	5.655; 0.506      5.825; 0.560      6.210; 0.711      6.959; 1.226	2,027,025

$$\mathcal{B}_n(0) = \prod_{i=1}^{n-1} \text{or } n \omega_i^2 \times \begin{cases} 1, & n \text{ even} \\ \sigma_l, & n \text{ odd.} \end{cases}$$