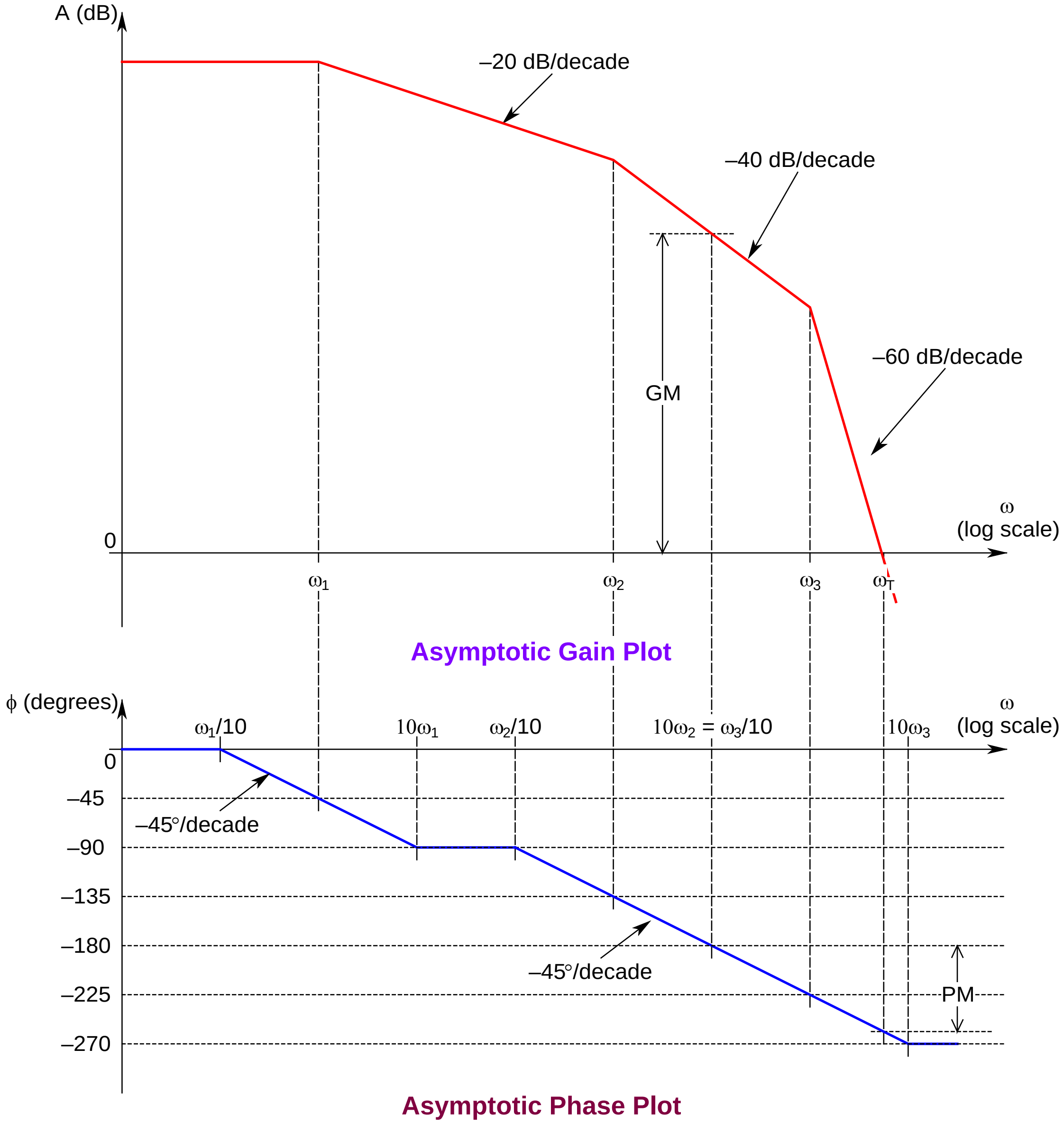
A (dB)
–20 dB/decade
–40 dB/decade
GM
–60 dB/decade
0
ω
(log scale)
ω1
ω2
ω3
ωT
Asymptotic Gain Plot
ϕ (degrees)
ω1/10
10ω1
ω2/10
10ω2 = ω3/10
10ω3
ω
(log scale)
0
–45
–90
–135
–180
–225
–270
–45°/decade
–45°/decade
PM
Asymptotic Phase Plot

- ***Profile of A*:**
  - ***Remains constant at its low-frequency value for $\omega \leq \omega_1$***
  - ***Then drops @ 20 dB/decade till ω_2***
  - ***Followed by a drop @ 40 dB/decade till ω_3***
  - ***Then drops @ 60 dB/decade***
  - ***Finally crosses 0 dB at ω (= ω_T : unity-gain cutoff frequency) slightly less than $10\omega_3$***
- ***Profile of ϕ*:**
  - ***Remains zero till $\omega_1/10$***
  - ***Then drops @ 45°/decade***

- ***Reaches –90° at 10ω_1***
- ***Stays constant at –90° till ω_2/10***
- ***Then starts to drop again @ 45°/decade till 10ω_3***
- ***Reaches –180° at 10ω_2 (= ω_3/10) and –270° at 10ω_3***

- ***Gain Margin*** (***GM***) and ***Phase Margin*** (***PM***):
  - ***Extremely important terms with regard to stability of a system***
  - ***From the sign and magnitude of these terms***, ***the stability of the system can be predicted***

- ***GM = A (dB)*** (***when $\phi = -180°$***)
- ***PM = 180° – |ϕ|*** (***when A = 0 dB***)
- In our example, ***GM is positive*** (as shown in the figure)
- This is ***potentially a dangerous situation***, and characterizes a ***highly unstable system***
  - For ***positive GM***, ***with each pass around the loop***, the ***output amplitude will keep on growing***
- On the contrary, if ***GM were negative***, ***with each pass around the loop***, the ***output amplitude would have decreased***

- ***The system would have come out of any unwanted oscillations***

- ***The GM dictates the maximum amount of feedback that can be allowed for the system to remain stable***

- ***For an unconditionally stable system*, *GM must be negative***

  $\Rightarrow$ ***A must be negative when*** $\phi = -180°$

- ***With regard to phase*, *when A crossed 0 dB*,** ϕ ***is close to*** $-270°$

  $\Rightarrow$ ***PM is negative*, *with a value of*** $\sim -90°$

- ***This also implies that when ϕ crossed –180°***, ***A of the system was greater than unity*** (***0 dB***)
  - ***A potentially dangerous situation in terms of stability***
- Therefore, ***for an unconditionally stable system***, ***PM must be positive***
- ***The two conditions with regard to GM and PM are actually correlated***
- ***Rule of Thumb***:
  - ***For a stable system***, ***GM ~ –10 dB and PM ~ 45° are generally good enough***

Compensation

- ***Basic Idea***:
  - To ***tailor*** the ***gain characteristic*** of a system, having ***three or more poles***, such that it would be ***stable*** for ***any value*** of the ***feedback factor*** f, all the way ***up to unity*** (referred to as the ***unity feedback system***, where the ***entire output*** is ***fed back*** to the ***input***)
  - ***After compensation***, the system will become ***either conditionally (f < 1) or unconditionally stable (f = 1)***

- ***Two widely used methods***:
  - ➢ ***Dominant Pole Compensation*** (***DPC***)
  - ➢ ***Pole Zero Compensation*** (***PZC***)
- ***Dominant Pole Compensation (DPC)***:
  - ➢ This technique introduces a ***dominant pole*** (***DP***) into the system
  - ➢ Also known as ***Miller Compensation Scheme***
  - ➢ This ***DP*** is chosen such that the ***compensated gain characteristic*** meets the ***first pole*** of the ***uncompensated system*** at ***0 dB***, with a ***slope*** of ***–20 dB/decade***