SOLVED EXAMPLES

Example 1. *An amplifier with negative feedback has an overall gain of 100. Variation of this gain of only ±1 percent can be tolerated for some specific use. If the open loop gain variations of ±10% are expected owing to production spreads in device characteristics, determine the minimum value of the feedback fraction β and also the open-loop gain to satisfy the above condition.*

We know that $$\frac{dA_f}{A_f} = \frac{1}{1 + A\beta} \cdot \frac{dA}{A}$$

Given that $$\frac{dA_f}{A_f} = \pm 1\% \text{ and } \frac{dA}{A} = \pm 10\%$$

$$\therefore \quad 1 + A\beta = \frac{dA}{A} \times \frac{A_f}{dA_f} = 10 \times 1 = 10$$

Again $$A_f = \frac{A}{1 + A\beta}$$

$\therefore$ Open-loop gain $A = A_f\,(1 + A\beta) = 100 \times 10 = \mathbf{1000}$

Now $$1 + A\beta = 10$$

$$\therefore \quad 1 + 1000\beta = 10 \quad \text{or} \quad \beta = 91000$$

$$\beta = \mathbf{0 \cdot 009}$$

Example 2. *An RC coupled amplifier has a voltage gain of 1000, $f_1 = 50$ Hz, $f_2 = 200$ kHz and a distortion of 5% without feedback. Find the amplifier voltage gain, $(f_1)_f$, $(f_2)_f$ and distortion when a negative feedback is applied with feedback ratio 0·01.*

The voltage gain of the amplifier with feedback

$$A_f = \frac{A}{1 + \beta A} = \frac{1000}{1 + 0 \cdot 01 \times 1000} = \mathbf{90 \cdot 9}$$

The lower 3 dB frequency

$$(f_1)_f = \frac{f_1}{1 + \beta A} = \frac{50}{1 + (0 \cdot 01 \times 1000)} = \mathbf{4 \cdot 5\ Hz}$$

The upper 3 dB frequency

$$(f_2)_f = f_2\,(1 + \beta A) = 200 \text{ kHz}\,(1 + 0 \cdot 01 \times 1000)$$
$$= 2200 \text{ kHz} = \mathbf{2 \cdot 2\ MHz}$$

The distortion with feedback

$$D_f = \frac{D}{1 + \beta A} = \frac{5}{1 + (0 \cdot 01 \times 1000)} = \mathbf{0 \cdot 45\%}$$

Example 3. *A negative feedback is used to reduce the noise from an amplifier by 80% (a) what must be the percentage of negative feedback to accomplish this, if the input voltage gain is 100? (b) What will be the voltage gain with feedback?*

(a) We know that reduction of noise of an amplifier with feedback is given by

$$0 \cdot 8 = 1 - \frac{1}{(1 + \beta A)} = 1 - \frac{1}{1 + \beta \times (100)}$$

or $$1 - 0 \cdot 8 = \frac{1}{1 + 100\beta} \quad \text{or} \quad 1 + 100\beta = (1/0 \cdot 2) = 5$$

$$\therefore \qquad \beta = \frac{4}{100} = 0 \cdot 04$$

(b) Voltage gain with feedback

$$A_f = \frac{A}{1+\beta A} = \frac{100}{1+(0 \cdot 04 \times 100)} = 20$$

Example 4. *An amplifier with $Z_i = 2\ k\Omega$ has a voltage gain $A = 2000$. If a negative feedback of $\beta = 0 \cdot 01$ is applied to it, what shall be the input impedance of the feedback amplifier?*

We know that $Z_{if} = Z_i\ (1 + A\beta)$

$$\therefore \qquad Z_{if} = 2 \times 10^3\ [1 + 2000 \times 0 \cdot 01]$$

$$= 2 \times 10^3\ (1 + 20) = 2 \times 10^3 \times 21$$

$$= 42 \times 10^3 = \mathbf{42\ k\Omega}$$

Example 5. *An amplifier has a mid band gain of 125 and a band width of 250 kHz. (i) If 4% negative feedback is introduced, find the new bandwidth and gain. (ii) If the band-width is to be restricted to 1 MHz find the feedback ratio.*

(i) We know that, $(BW)_f = (1 + A\beta)\ BW$

Substituting the given values, we get

$$(BW)_f = (1 + 125 \times 0 \cdot 04) \times 250 \times 10^3\ \text{Hz}$$

$$= 1 \cdot 5 \times 10^6\ \text{Hz} = \mathbf{1 \cdot 5\ MHz}$$

Gain with feedback, $A_f = \dfrac{A}{1 + A\beta} = \dfrac{125}{1 + 125 \times 0 \cdot 04} = \mathbf{20 \cdot 83}$

(ii) $(BW)_f = (1 + 125\beta') \times 250 \times 10^3$

or $$1 \times 10^6 = (1 + 125\beta') \times 250 \times 10^3$$

or $$(1 + 125\beta') = (1 \times 10^6)/(250 \times 10^3)$$

Solving for β', we get $\beta' = 0 \cdot 024 = \mathbf{2 \cdot 4\%}$

Example 6. *An R-C coupled amplifier has a mid-frequency gain of 200 and a frequency response from 100 Hz to 20 kHz. A negative feedback network with $\beta = 0 \cdot 02$ is incorporated into the amplifier circuit. Calculate the bandwidth.*

We know that $$f_1' = \frac{f_1}{1 + (A_v)_m\ \beta}$$

$$\therefore \qquad f_1' = \frac{100}{1 + 200 \times 0 \cdot 02} = 20\ \text{Hz}$$

Further, $$f_2' = f_2\ \{1 + (A_v)_m\ \beta\}$$

$$\therefore \qquad f_2' = 20\ \{1 + (200)\ 0 \cdot 02\} = 100\ \text{kHz}$$

The bandwidth with feedback is given by

$$(BW)_f = f_2' - f_1'$$

$$= 100\ \text{kHz} - 20\ \text{Hz} \approx \mathbf{100\ kHz}$$

Example 7. *An amplifier has a mid-frequency of 800. Its upper and lower cut-off frequencies f_2 and f_1 are 16 kHz and 40 kHz respectively. Determine the band width of the amplifier. What will be the band width after 2% of the signal output is given as negative feedback?*

We know that, $$A_f = \frac{A}{1+\beta A} = \frac{800}{1+0\cdot02\times800}$$

$$= \frac{800}{17} = 47$$

Bandwidth without feedback $= f_2 - f_1$

$\therefore$ $$BW = 16000 - 40 = \mathbf{15\cdot96\ kHz}$$

Cut-off frequencies after feedback

$$f_2' = f_2\,(1 + A\,\beta) = 16000 \times 17$$

$$= 272000 = 272\text{ kHz}$$

$$f_1' = \frac{f_1}{(1 + A\,\beta)} = \frac{40}{17} \approx 2\text{ Hz}$$

$\therefore$ Band width after feedback $= f_2' - f_1'$

$$= 272000 - 2 \approx \mathbf{272\ kHz}$$