Y2

Problems

1. An amplifier has a feedback fraction β equal to 0.1. Calculate the overall gain with feedback, A_f, if the open loop gain A_{ol} has the following values (a) 10; (b) 50; © 100; (d) 500; (e) 1000. From these results what would you guess the limiting value of A_f would be as A_{ol} tends to infinity? Compare this guess with the value of $1/\beta$.
2. An amplifier with an open loop gain A_{ol} of 2500 can have the following possible β values (a) 0.2; (b) 0.4; © 0.8; (d) 1.0. Calculate the values of the overall gain with feedback A_f in each case and compare with the limiting values of A_f when A_{ol} tends to infinity (i.e. $1/\beta$).
3. Calculate the value of x_{in} for the circuit shown in fig.P3.1 when $x_g = 1$, if $A_{ol} = 1000$, $\beta = 0.1$. Has the feedback increased or decreased x_{in}? (Without feedback $x_{in} = x_g$). What would the limiting value of x_{in} be as A_{ol} tends to infinity?
4. Consider the circuit shown in fig. P3.2, in which the input signal x_g has been reduced to zero and the feedback path is broken at the output. Calculate the ratio x'_o/x_o. Now consider the circuit shown in fig. P3.3, in which the connection between the summing junction and the amplifier input has been broken. Calculate x'_{in}/x_{in}. [In both cases, the answer is $-A_{ol}.\beta$. I hope you can now see why this quantity, (without the negative sign) is called the *loop gain*.].
5. An amplifier has an open loop gain of 2400 when the transistors used in its construction have a common emitter gain of 100. If the feedback fraction is 1/21, calculate the overall gain with feedback, A_{f1}. (You will need to express your answer to 3 decimal places). If now the transistors are replaced, so that the open loop gain rises to 2600, calculate the new gain with feedback, A_{f2}. Hence calculate the fractional change in overall gain given by

$$\frac{\Delta A_f}{A_f} = \frac{A_{f2} - A_{f1}}{A_{f1}}$$

   Compare this result with that using the equation given in the lecture.
6. We found that A_f can be approximated by $1/\beta$. The error made in making this assumption can be defined as the *fractional gain error (FGE):*

$$\mathrm{FGE} = {\left(\frac{1}{\beta} - \frac{A_{ol}}{(1+A_{ol}.\beta)}\right)} \Big/ {\frac{A_{ol}}{(1+A_{ol}.\beta)}}$$

   Calculate the FGE if $\beta = 1/21$ and $A_{ol} = 2400$ as a percentage.
7. The feedback network is normally made up of resistors. These will have a finite tolerance, for example 1%. As a result, the value of β will be unknown to some tolerance as well. Suppose β lies in the range 0.100 ± 0.002. What is the range of A_f expected if A_{ol} is 1600. Can you use calculus to find the answer?

8. Calculate the overall gains with feedback x_o/x_g for the circuits shown in fig. P3.4. Show that if the overall gains of these circuits are to be the same, then

$$\beta_1 = \frac{2.\beta_2}{A_{ol}} + \beta_2^2$$

Now calculate the overall gains on the assumption that A_{ol} is extremely large. Show that with this approximation the gains are equal when $\beta_1 \approx (\beta_2)^2$. If the overall gain of both circuits is to be 10 with Aol = 100, calculate suitable values for β_1 and β_2.

Fig. P3.1

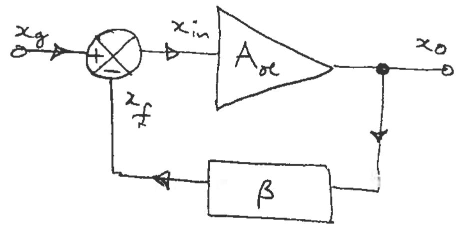

Fig. P3.2

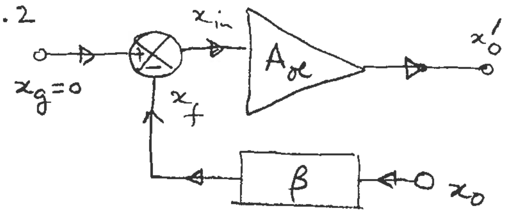

Fig P3.3

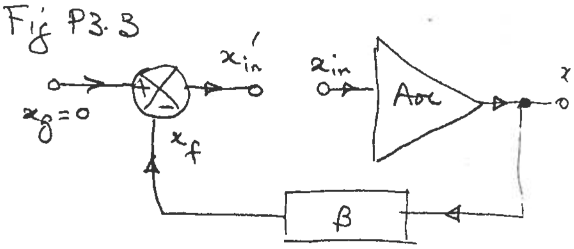

Fig P3.4