1. A mobile phone receives a signal level of 10 μV, but it must deliver a swing of 10 mV to the speaker that reproduces the voice. Calculate the required voltage gain in decibels (dBs). (10 points)

2. Prove the "small-signal resistance" (r_d) of a diode at forward bias is equal to $r_d = \frac{V_T}{I_D}$. (10 points)

3. Compute the voltage gain, input impedance, and output impedance of the circuit depicted in Fig. 1. Assume a very large value for C_1. (20 points)

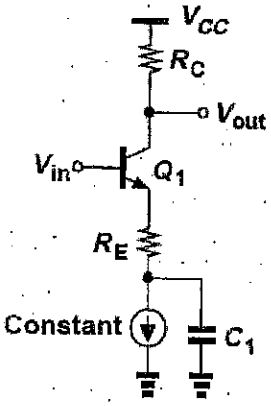

Fig. 1

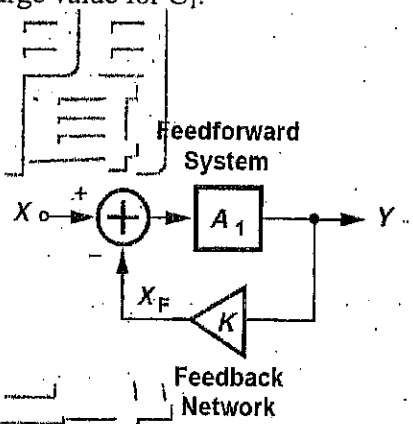

Fig. 2

4. Fig. 2 shows a general feedback system. Suppose the amplifier $A_1(s)$ can be represented as follows: $A_1(s) = \frac{A_0}{1 + \frac{s}{\omega_0}}$, in which A_0 denotes the low-frequency gain and ω_0 the –3-dB bandwidth. Prove the closed-loop system exhibits:

(a) Closed-loop gain $= \frac{A_0}{1 + KA_0}$. (10 points)

(b) Closed-loop bandwidth $= (1 + KA_0)\omega_0$ (10 points)

5. Determine the transfer function and frequency response of the common-source stage shown in Fig. 3. (20 points)

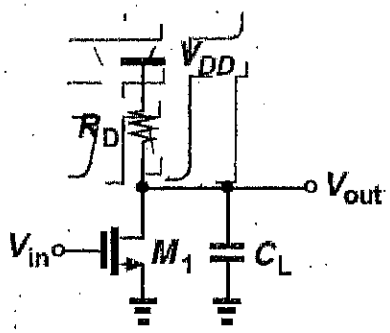

Fig. 3

6. For the KHN bi-quad in Fig. 4,

(a) Prove V_{out}/V_{in} is a second-order high-pass function. (8 points)

(b) Prove V_X/V_{in} is a second-order band-pass function. (6 points)

(c) Prove V_Y/V_{in} is a second-order low-pass function. (6 points)

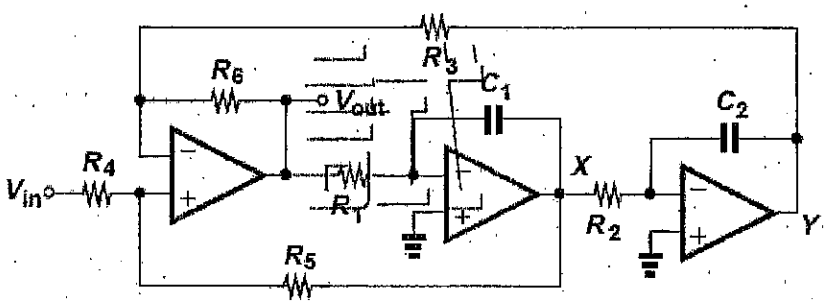

Fig. 4