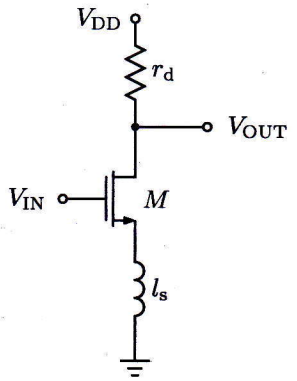
ELEC-E3120 Analysis and Design of Electronic Circuits — Exam 13.12.2018

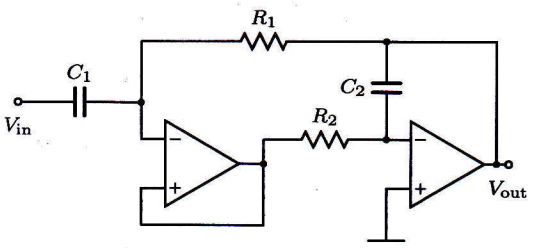
This exam includes five problems. Note that the last ones are at the other side of the paper. Each problem gives 10 points at maximum.

1.

Answer shortly with few words to the following questions.
a) How nonlinearity affects the operation of the circuit? Specify at least two issues. (2p)
b) Draw the frequency response (Bode plot) for the second-order low-pass filter. (2p)
c) When analyzing digital systems what it means to multiply by z^{-1}? (2p)
d) For the given circuit, draw a small-signal model, which can be used to determine the transfer function. (4p)



2.



The voltage transfer function of a band-pass filter is

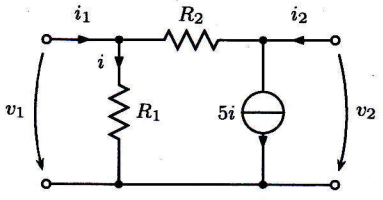
$$H(s) = \frac{-sC_1G_2}{s^2C_1C_2 + sC_2G_1 + G_1G_2}$$

Answer to following questions:
a) At what frequency has the gain the maximum?
b) What is the -3 dB bandwidth $\Delta\omega$ of the circuit?
c) What is the Q value of the circuit?
d) What is the maximum value of the gain?

$$H(s) = \frac{p(s)}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$R_1 = 5\ \text{k}\Omega \quad R_2 = 2\ \text{k}\Omega \quad C_1 = 1\ \mu\text{F}$
$C_2 = 0.1\ \mu\text{F}.$

3.



Find the hybrid parameter model of the circuit.

$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} \qquad h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0}$$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0} \qquad h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$$

$R_1 = 1\ \Omega \quad R_2 = 9\ \Omega.$

4.

- The input type of your amplifier is voltage. The amplifier has input resistance of R_i and open loop gain of K. If you use feedback of β, what will your input impedance for the feedback system be?
- The output type of your amplifier is current. The amplifier has output resistance of R_o and open loop gain of K. If you use feedback of β, what will your output impedance for the feedback system be?
- You have an amplifier which has open loop gain of 80 dB and -3 dB frequency of 10 kHz.
  - You need a bandwidth of 1 MHz. What should your β be?
  - Is the change possible, if you also need closed loop gain of at least 40 dB?

5.

The figure shows the scattering parameters of a two port. Answer shortly to following questions.
a) At which frequency the coupling between the ports is largest?
b) How does the circuit work if you feed a signal to port 2 at frequency 1.8 GHz?
c) At which frequency has port 1 the best matching?
d) At which frequency range has port 2 matching level better than -10 dB?
e) What is the optimal value for S_{21} if you want to maximize power transfer from port 1 to port 2?