FYSE301, Electronics 1A, spring 2011
Final exam 18th March 2011. Do all five problems!

1. Explain briefly: (6 points)
a) Ideal operational amplifier
b) Voltage-current behaviour of a pn junction
c) The effect of doping to the electronic conductivity of a semiconductor

2. Calculate the current I_L through resistor R_L (Fig. 1.) by converting the remaining circuit (dashed line area) to its Thevenin equivalent and express I_L as a function of R_L (do not fix the value for R_L yet). Calculate I_L when $R_L = 30\ \Omega$. (6 points)

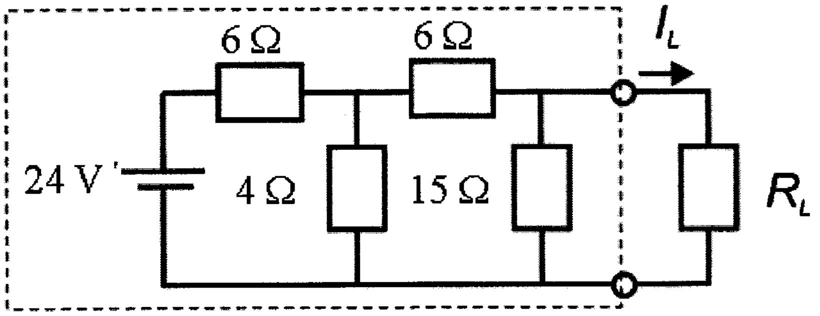

Fig. 1

3. Calculate the amplification $A = v_o / v_i$ and input resistance $R_i = v_i / i_i$ in a circuit shown in Figure 2 when switch K is
   a) Short circuited,
   b) Open.
   Assume that the operational amplifier is ideal.(6 points)

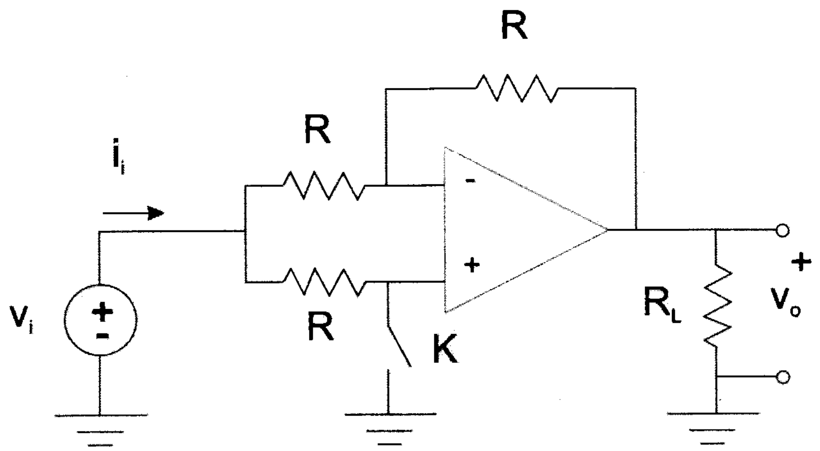

Fig. 2.

4. Determine the voltage $V_{AB} = V_A - V_B$ between points A and B and the current i for the circuit in Figure 3 (left), when a
   a) Resistor, $R = 7\ \Omega$ is connected between the points A and B.
   b) Ge-diode, whose current i as a function of its voltage $v = V_{AB} = V_A - V_B$ is $i(v) = I_0\,[\exp(v/V_0) - 1]$, where $I_0 = 2\ \mu A$ and $V_0 = 26$ mV, is connected between the points A and B. The iv-curve for the diode is given in figure 3 (right). (6 points)

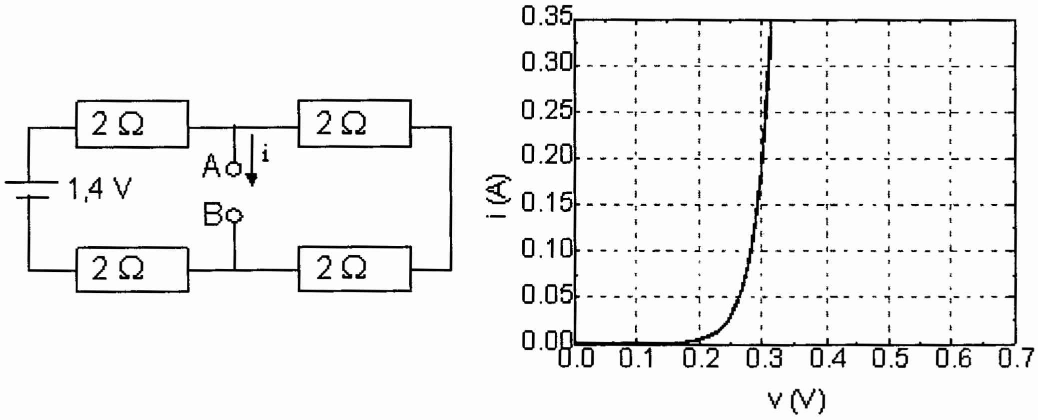

Fig. 3

5. In Figure 4 there is a biasing circuit that sets the quiescent (operation) point for MOSFET-transistor. Choose R_S and R_D such that $i_D = 1$ mA and $V_{DS} = V_D - V_S = 8$ V, when $V_{DD} = 20$ V. The parameters for enhancement-only mode NMOS-transistor (in saturation) are $K = 0.25\ mA/V^2$ and $V_T = 2$ V. Let $R_{g1} = R_{g2} = 1$ MΩ. (6 points)

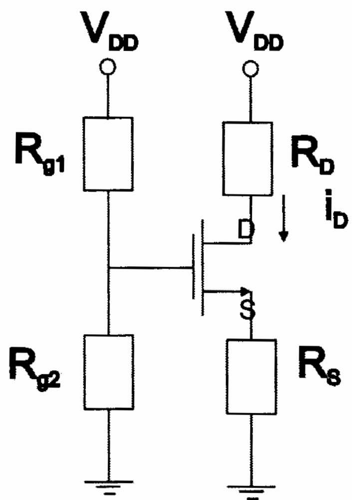

Fig. 4.

Perhaps useful equations: $\sigma = ne\mu$; $n = p = n_i$; $n_i = e^{-Eg/2kT}$; $i = I_s(e^{ev/\eta kT} - 1)$; $i_D = K(v_{GS} - V_T)^2$; $i_D = I_{DSS}(1 - v_{GS}/V_P)^2$; $\beta = \alpha/(1 - \alpha)$;