Basic Electronics (EC21101)

End Semester Examination

Spring 2010 Full marks : 75

Answer all questions. The marks for each question is indicated to the right.

1. (a) Determine the built-in potential barrier V_{bi} in a Si pn junction with an intrinsic carrier concentration $n_i = 1.5 \times 10^{10}$ cm^{-3} for (i) $N_d = N_a = 10^{16}$ cm^{-3}; (ii) $N_d = 10^{18}$ cm^{-3}, $N_a = 10^{16}$ cm^{-3}; and (iii) $N_d = N_a = 10^{18}$ cm^{-3}.

   (b) Assume each diode in the circuit shown in Fig. 1 to have a cut–in voltage of $V\gamma = 0.65V$. (i) For an input voltage of $V_i = 5V$, determine the value of R_1 required such that the current I_{D1} is one half of the value of the current I_{D2}. What are the values of I_{D1} and I_{D2}? (iii) If $V_i = 8V$ and $R_1 = 2k\Omega$, determine the currents I_{D1} and I_{D2}.

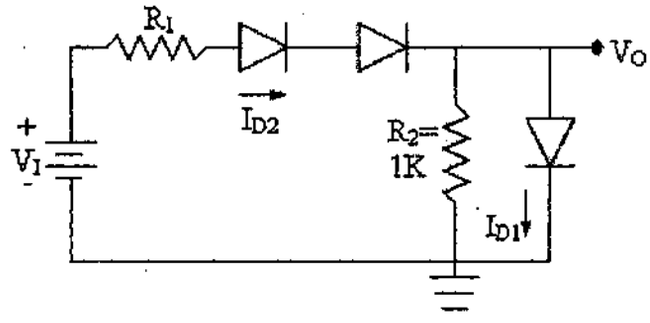

Fig. 1 [3+7=10]

2. Find the value of R_1, R_2, R_s and R_D in the circuit shown in Fig. 2 for $I_{DQ} = 0.25$mA and $V_{DSQ} = 4V$ with the voltage across R_s at 1V. Assume that the current through R_1 is 20μA. The NMOS parameters are as follows : $k_n' = 80\mu A/V^2$, $V_{TN} = 1.2\,V$ and $W/L = 4$.

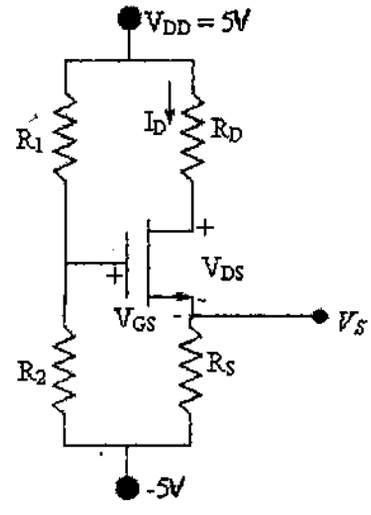

Fig. 2 [10]

3. Assume V_γ = 0.7V for each diode. Plat V_0 versus V_i for -10V < V_i < +10V for the circuit shown in Fig. 3.

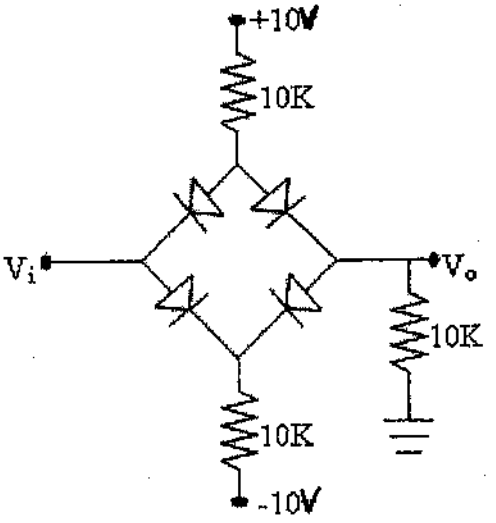

Fig. 3 [8]

4. Calculate the small signal voltage gain of the common source amplifier shown in Fig. 4, with $g_m = 1\,mA/V$, $r_0 = 50k\Omega$ and $R_D = 10k\Omega$. Assume $R_{Si} = 2\,k\Omega$ and $R_1 \| R_2 = 50\,k\Omega$.

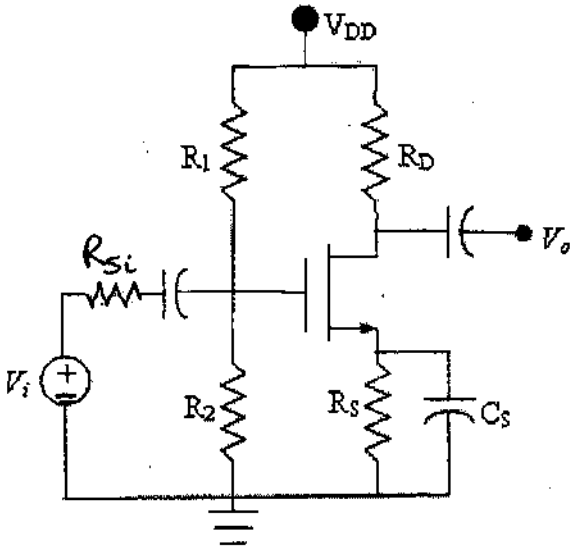

Fig. 4 [7]

5. (a) Consider the circuit shown in Fig. 5. The transistor parameters are $\beta = 100$ with the Early voltage $V_A = 100$ V. Determine the input resistance R_i, the voltage gain $A_v = v_o/v_s$ and the current gain $A_i = i_o/i_s$.

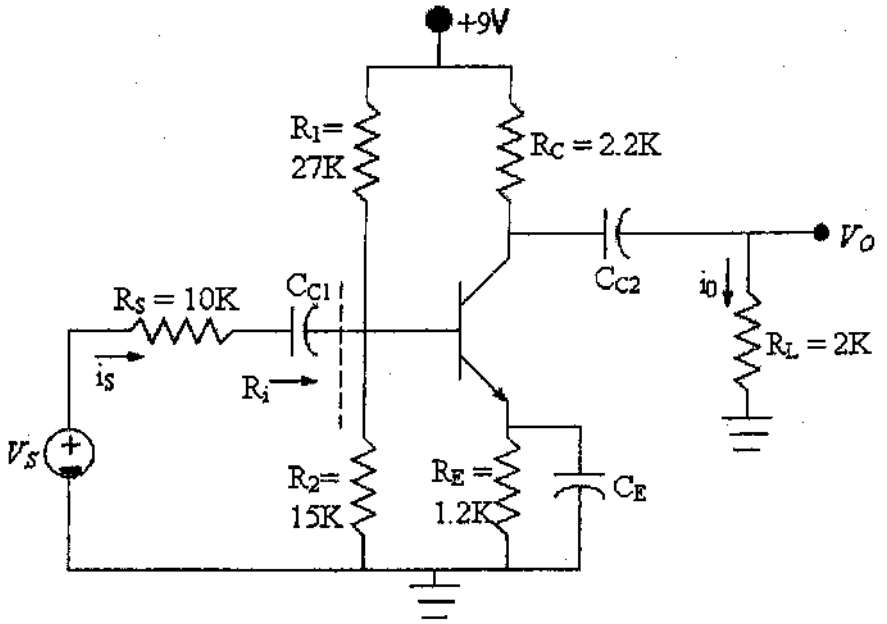

Fig. 5 [12]

(b) Assume that $\beta = 100$, $R_1 = 10$ kΩ and $R_2 = 50$ kΩ, with the Early voltage $V_A = \infty$ for the circuit shown in Fig. 6. (i) Determine the small signal voltage gain. (ii) Also find the range of voltage gain if the resistance values R_E and R_C vary by ± 5 %.

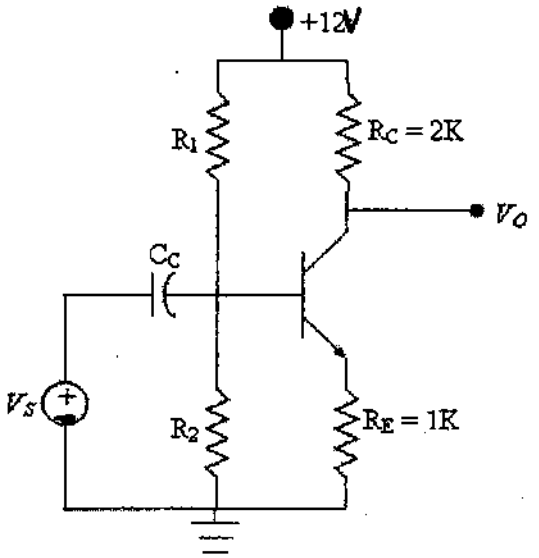

Fig. 6 [12 + 6 = 18]

6.

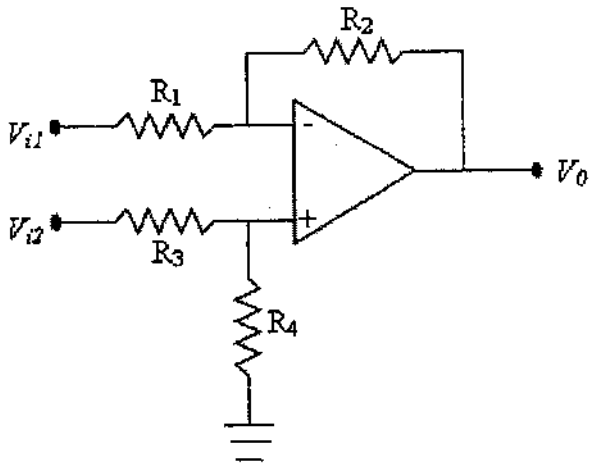

Fig. 7

In the differential amplifier shown in Fig. 7, $R_1 = R_3 = 10k\Omega$, $R_2 = 20\ k\Omega$ and $R_4 = 21\ k\Omega$. Determine V_0 when $V_{i1} = +1\,V$ and $V_{i2} = -1\,V$ [10]