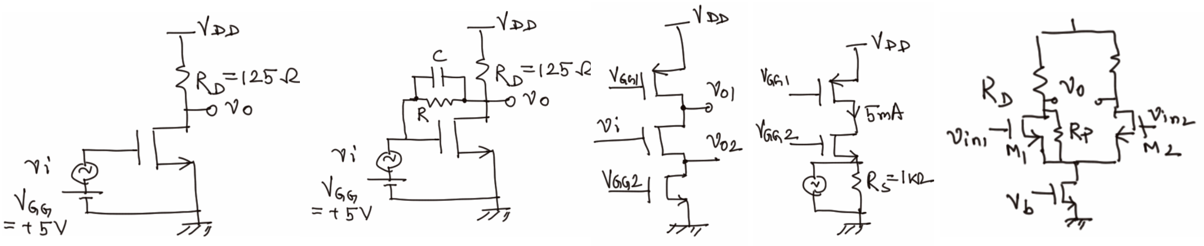
Device Details

Use these parameters unless stated otherwise.

- nMOS - $V_{T,n} = +1$ V, $k_n^{'} = 10$ mA/V^2, $\lambda = 0.1$ V^{-1}.
- pMOS - $V_{T,p} = -1$ V, $k_p^{'} = 10$ mA/V^2, $\lambda = 0.1$ V^{-1}.
- $V_{DD} = +15$ V, $V_{SS} =$ -15 V
- All the transistors are operating in the saturation region during small signal operation if the biasing condition is not implicitly/explicitly mentioned.

Answer all the questions. Total Marks = 20.



(a) Q1. (b) Q2. (c) Q3. (d) Q4. (e) Q5.

Figure 1: Figures for questions 1-5.

1. Consider the amplifier shown in Fig. 1a assuming $\lambda = 0$:
   (a) Which terminal is common to both input and output under small signal operation? (1/2)
   (b) Find outv_0 for a small signal input, $v_i = 10^{-3}\angle\pi/3$. (3)
   (c) Find out the output impedance including the effect of R_D. (1/2)
2. Consider the circuit shown in Fig. 1b. Assume, $C_{GS} = C_{GD} = 0$, $\lambda = 0$, $R_D = 125\ \Omega$, $R = 1$ MΩ and $C = 1$ nF.
   (a) Find out the frequency at which gain falls by 3 dB in comparison to that at low frequency. (3)
   (b) Find out the frequency at which gain decreases by 28 dB. (1)

   You can use Miller's theorem.
3. Consider the circuit shown in Fig. 1c. Assume the transistors are biased with a current of, $|I_{DS}|$ = 5 mA. Find out the small signal gain $(v_{O1} - v_{O2})/v_i$. (4)
4. Consider the circuit shown in Fig. 1d. The small signal ac input is a current i connected in parallel with R_S. The output is taken from the drain of nMOS. Assume, $R_S = 1k\Omega$ and bias current of 5 mA.
   (a) Find out the minimum value for V_{DD} so that both the transistors are in saturation. Find out corresponding V_{GG1} and V_{GG2}. (1+1)
   (b) Considering the circuit as a trans-impedance amplifier, find out the gain with proper unit. (2)
5. Due to a manufacturing defect, a large parasitic resistance R_P has appeared between the drain and source terminals of M1 in Fig. 1e. Assuming $\lambda = 0$, calculate the small-signal gain, common-mode gain, and CMRR. ($1\frac{1}{2}$+$1\frac{1}{2}$+1)