Prob-1. Determine in which of the two cases (a) $g_{mp} > g_{mn}$ (b) $g_{mp} < g_{mn}$ the circuit will be unstable and why? $g_{mp}$ and $g_{mn}$ are respective transconductances of MP and MN.
Prob-2. A second order system has an open loop transfer function \( H(s) = \frac{2000}{(\frac{s}{10} + 1)(\frac{s}{p} + 1)} \) and feedback factor of \( \beta \).

Determine the location of pole \( p \) for which the loop phase margin is \( 45^\circ \) if (a) \( \beta = 1/2 \) and (b) \( \beta = 1/20 \). Show the bode plot of loop transfer function for both the cases.
**Prob-3.** Figure below shows a non-inverting amplifier achieved by connecting an opamp in negative feedback configuration. Assuming open loop gain of opamp $A=\infty$, the closed loop gain $V_{out}/V_{in}$ of the circuit is given by $1+R_1/R_2$ which is simply $1/\beta$ where $\beta$ is the feedback factor $R_2/(R_1+R_2)$. Find the expression for closed loop gain if $A$ is finite and determine % error in the closed loop gain for (a) $A=1000$ and (b) $A=10000$. 

![Non-inverting Amplifier Diagram]
**Prob-4.** A system is said to be unstable if any of the poles lie in right half of the s-plane. This property can be used to convert a second order system into oscillator by using negative feedback and choosing a proper feedback function. Find the closed loop transfer function $V_{out}(s)/V_{in}(s)$ of the system and show how the location of poles change w.r.t $k$ in s-plane.

$$H(s) = \frac{A}{s^2 + \frac{w_n}{Q_0} s + w_n^2}$$
Prob-5. A common source amplifier with DC gain \( gmR \) and pole location \( wp=1/RC \) is connected in negative feedback configuration as shown in figure below. Determine the closed loop transfer function \( V_{out}(s)/Vin(s) \), closed loop DC gain and closed loop -3dB bandwidth of the circuit. Show the bode plot for gain and phase for (a) \( \beta=0 \) (b) \( \beta=1 \) and (c) \( \beta=1/2 \) and compare the DC gain and Bandwidth of the closed system with that of open loop gain and bandwidth of common source amplifier. Consider \( r_o=\infty \).
**Prob-6** For the circuit shown below, considering each pole causes a $3dB$ drop in gain at pole frequency, find (a) minimum gain $k$ if $R=1\,k\Omega$ and (b) minimum value of $R$ if $k=0.25$ for which the circuit will oscillate and determine the expression for frequency of oscillation in both the cases. Consider $r_o=\infty$ and $g_m=1m\,A/V$ for all the PMOS.

![Circuit Diagram]
Prob-7. For the linear oscillator shown, find the oscillation frequency $\omega_0$ and $R_X$ value required to ensure oscillation.
Prob-8. Plot the waveforms at Vout and Vx. Mark the voltages clearly and determine the frequency of oscillation.
**Prob-9.** Note all critical voltage levels in the $V_x$ waveform. Sketch $V_{out}$ waveform, with proper time alignment and voltages. Find the resulting period ($T_{osc}$) of oscillation.