The ac schematic of a common-base stage is shown below, where $i_i$ is the signal input.

![Schematic Diagram](image)

Neglect effects of dc Beta.

Bias current $I_{CQ} = 1 \text{ mA}$, $r_f = 20 \text{ pS}$, $R_L = 1 \text{ k} \Omega$ and $C_{je} = 0.2 \text{ pF}$ (assumed constant) at the bias point. Neglect the effect of $r_b$ and $C_\mu$.

1. Calculate functional expressions for the first and second order Volterra coefficients linking $i_i$ and $v_o$.

2. Calculate $IM_3$ in $v_o$ for two signals of equal output amplitude $100 \text{ mV}$ rms and approximately equal frequencies of $400 \text{ MHz}$. Make use of the approximation that the signal frequency is much less than $f_T$.

Verify using SPICE.
A simplified schematic of a variable gain amplifier is shown below. \( V_{B1} \) and \( V_{B2} \) are dc voltages and the gain control voltage \( V_C = V_{B1} - V_{B2} \). Current \( I_A \) is bias and \( i_S \) is the signal input.

Neglect the effects of \( \beta, C_{je}, C_{le} \) and \( C_{C5} \). Show that for high attenuation, the high-frequency distortion in the circuit becomes independent of attenuation by considering the effects of finite \( f_T \) and \( r_b \). Assume that the effect of \( r_b \) in \( Q_1 \) is negligible (low bias current) and that \( I_{C1} \ll I_{C2} \).

Thus calculate \( HD_2 \) in the circuit for a signal input \( i_S = 0.1 \) mA at 500 MHz with \( I_A = 1 \) mA, \( \tau_p = 30 \) pS and \( r_b = 100 \Omega \).