34 3

$$\frac{D}{\mu} = \frac{kT}{q}$$

$$V_x = V_T \ln\left(\frac{I_x}{I_s}\right)$$

$$I_d = D_n \times \frac{dn}{dx} \times A \times q$$

26mV

$$V_d = \frac{kT}{q} \times \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

$$J = J_n + J_p$$

$$I_s = A q n_i^2 \left(\frac{D_n}{L_p \cdot N_A} + \frac{D_p}{L_p N_D}\right)$$

$$V_T = \frac{kT}{q}$$

$$I = \cancel{I_s \exp\left(\frac{V_D}{V_T}-1\right)}$$

$$I = I_s\left(\exp\left(\frac{V_D}{V_T}\right) - 1\right)$$

$$C_j = \frac{C_{j0}}{\sqrt{1+\frac{V_R}{V_0}}}$$

$$C_j = \frac{\varepsilon A}{W}$$

$\mathcal{E} = q * N_A * W_p / \text{epsilon} = q * N_D * W_n / \text{epsilon}$

$$5.22\times10^{15}\, e^{\frac{-E_g}{kTq}} \times T^{3/2}$$

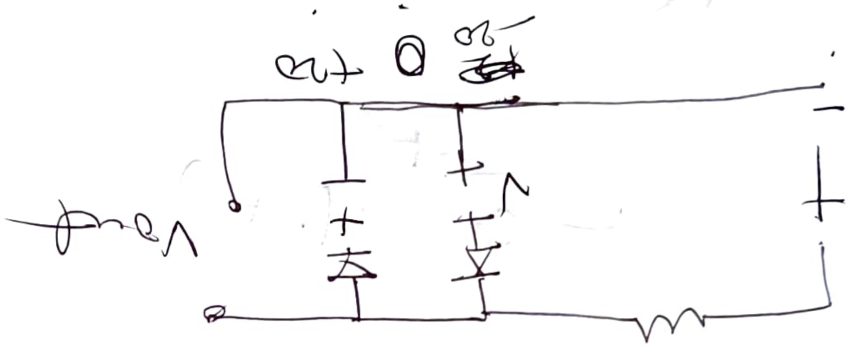
$$r_d = \frac{n \times V_T}{I}$$

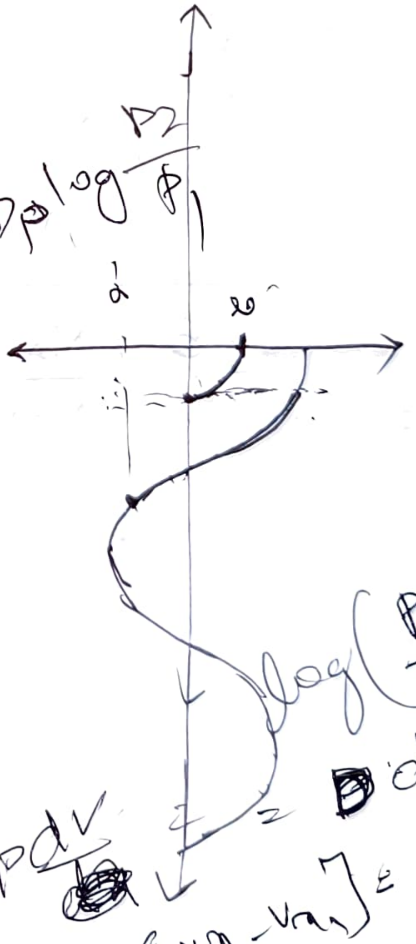
n_i

$$n \cdot p = n_i^2$$

$n_p = n_n$

$$n = p \qquad n\cdot p = n_i^2$$





$$dp[V_{a_2} - V_{a_1}] = D_p \log\frac{P_2}{P_1}$$

$$q \times A \times \frac{dn}{dx}$$

$$dp\,dV = D_p \log\left(\frac{P_2}{P_1}\right)$$

$$dp\,[V_{a_2} - V_{a_1}] =$$

$x(t) = \cancel{\cos} \sin(\omega t) \cancel{dt}\, u(t)$

$$\frac{\omega_0}{s+\omega_0^2} \qquad \frac{s}{s^2+\omega_0^2}$$

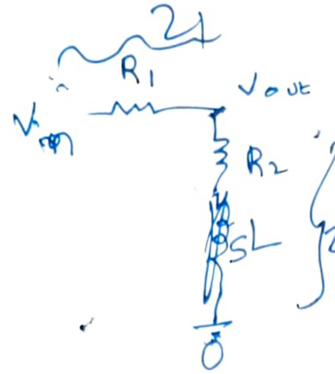
$$\frac{1}{s+a}$$

$$e^{-at}\, u(t)$$

$$-e^{-at}\, u(-t)$$

$$\frac{t^{n-1}}{(n-1)!} e^{-at} u(t) \qquad \frac{1}{(s+a)^n}$$

$$W = \sqrt{\frac{2\varepsilon}{q}\left(\frac{N_A+N_B}{N_A N_B}\right) \times (V_b - V)}$$



Z_2 $\frac{V_{out}}{R_2+SL} = \frac{V_{in}-V_{out}}{R_1}$

R

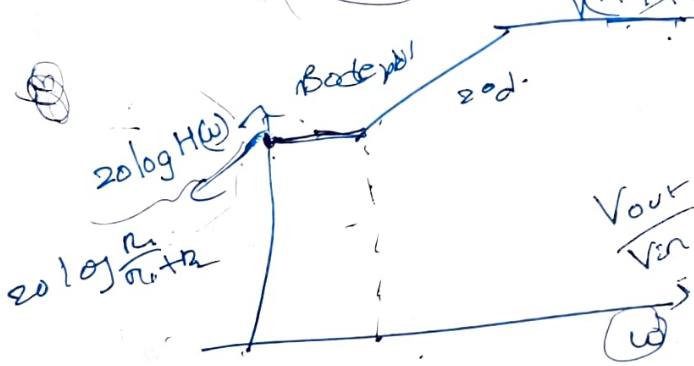
V_0

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{R_2+SL}{R_1+R_2+SL}$$

$$|H(\omega)| = \frac{\sqrt{R_2^2+(\omega L)^2}}{\sqrt{(R_1+R_2)^2+(\omega L)^2}}$$

$\sqrt{R}$

ω



$\frac{V_{out}}{V_{in}} = \frac{Z_2}{Z_1+Z_2}$

$|H(\omega)|$

$20\log\left(\frac{R_2}{R_1+R_2}\right)$

$Z_2=0$

V_{out} $\omega = \frac{R_2}{L}$

$20\log = \frac{\omega L}{R_1+R_2}$

$20\log(1)$ t

$20\log(\omega L)$ → $20\log$

$10\log\left(\frac{I}{I_0}\right)$ dB

20

$V_{out}=V_{in}$

$$V_{in} - iR_1 - iR_2 + L\left(\frac{di}{dt}\right) = 0$$

$\phi = LI$

$\frac{d\phi}{dt} = L\frac{di}{dt}$

$\frac{V_{in}R_2}{R_2+R_1}$

$$i = \frac{V_{in}}{(R_1+R_2)}\left(1 - e^{-\frac{t(R_1+R_2)}{L}}\right)$$

$i=0$

V_{in} ~~V_{out}~~ $= \frac{V_i R_2}{R_1+R_2}$

$$\frac{V_{out}}{V_{in}} = \frac{Z_2}{Z_1 + Z_2}$$

$Z_2 = 0$ @ $\dfrac{R_2 + SL}{R_1 + R_2 + SL}$

$Z_2 = \infty$

$Z_1 = \infty$

$\dfrac{Z_2}{\infty} < 0$

$Z_2 \neq \infty$

$A_{DC} + R_2 + SL$

$Z_2 = 0$ $\quad Z_1 = \infty$

$\cancel{Z_1 \neq 0}$ $\quad Z_2 \neq \infty$

$$H(s) = \cancel{A_D} K'' \left(1 + \frac{1 + \frac{SL}{R_2}}{\quad}\right.$$

$R_1 + R_2 + SL = 0$

$$S = -\frac{R_1 + R_2}{L}$$

$$K \left(\quad H(s) = \frac{\left(1 + \frac{S}{Z_1}\right)\left(1 + \frac{SL}{R}\right)}{\left(1 + \frac{S}{P_1}\right)\left(1 + \frac{S}{P_2}\right)}\right.$$

$$H(s) = \frac{S = -P_1}{\left(1 + \frac{LS}{R_1 + R_2}\right)\frac{1}{\infty}}$$

$S + Z_1 = 0$

$\dfrac{1 + \frac{S}{Z_1}}{\quad}$ $\quad S = -Z_1$

$S = -P_1$

$1 + \dfrac{S}{Z_1} = 0$

$\boxed{S = -Z_1 \quad \cancel{H(s) =}}$

$$\frac{\quad}{\left(1 + \frac{S}{\cancel{R_2} R_2 / L}\right)} \quad S = \frac{\quad}{\left(1 + \frac{S}{P}\right)}$$

$R_2 + SL$ $\quad 1 + \dfrac{LS}{(R_1 + R_2)}$ $\quad P =$

$Z_2 =$

$S = -\dfrac{R_2}{L}$ $\quad \dfrac{R_1 + R_2 + SL}{\quad}$

* Norton's theorem.

* $n_i = 5.2 \times 10^{15}\, T^{3/2} \exp \frac{-E_g}{2kT}$ electrons/cm^3

No. of $e^{\ominus}$ per unit volume / How many electrons generated at given T

$k \rightarrow 1.38 \times 10^{-23}$ J/K

* E_g for silicon $= 1.12$ eV — this also depends on E_g and T.

↓

Bandgap energy: [for Ge. 0.67eV, Dia (2.5eV)]

min. energy required to dislodge an $e^{\ominus}$ from covalent Bond.

* S.C → 1_{eV} – 1.5 eV bandgap

* atom density silicon 5×10^{23} atom/cm^3.

* at RTP 300K 1.08×10^{10} e/cm^3

1.08×10^{10} h/cm^3

For every

1 $e^{\ominus}$ for 5×10^{12} atom

* $n.p = n_i^2$

* (dopant) → phosphorous — intrinsic semiconductors = extrinsic S.C

$N_D >> n_i$ $\quad p \cancel{n} = n_i^2 \Rightarrow p N_D = n_i^2$ ($n \rightarrow N_D$; N_D majority, p minority)

$10^{15} - 10^{18}$ atoms/cm^3.

$V_d = \frac{eE\tau}{m} = \mu E$ $\qquad \boxed{\mu = \frac{V_d}{E}}$

$\mu_n = 1350\, cm^2/V{\cdot}s$

$\mu_p = 480\, cm^2$

$\vec{V_e} = -\mu_n \vec{E}$

$J = (\mu_n n q + \mu_p p q) E = \sigma E$

$\mu_n n = \mu_p p$.

$$I_D = I_s\left(\exp\frac{V_D}{V_T} - 1\right)$$

$$D = \mu \frac{kT}{q}$$

$$\mu_p = \mu_n/3$$

$$C_1 V_0 = C_1 V + C_2 V$$

$$\frac{C_1 V_0}{C_1 + C_2} = V$$

$$\frac{1}{s+10} \quad \frac{1}{s+50}$$

$$Q = \frac{C}{V}$$

$s+50-s-10$

$40-3s$

$$H(s) = \frac{1}{(s+10)(s+50)}$$

$|H(s)| =$