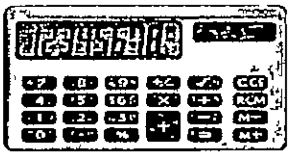
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

ECT2601
RCT2601

October/November 2017

ELECTRONICS II (THEORY)

Duration 3 Hours

100 Marks

EXAMINERS
FIRST MR PO UMENNE
SECOND MR NR NETSHIKWETA

Programmable pocket calculator is permissible

Closed book examination

This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue

This examination question paper consists of 9 pages including this "cover" plus 3 pages formulae sheets

Answer all questions

PLEASE NOTE. IF YOU HAVE THE OPINION THAT INSUFFICIENT INFORMATION IS SUPPLIED FOR YOU TO ANSWER A PARTICULAR QUESTION, MAKE A REALISTIC ASSUMPTION, MOTIVATE IT AND THEN ANSWER THE QUESTION.

BIPOLAR JUNCTION TRANSISTORS (BJT)

QUESTION 1

The transistor in figure 1 has the following maximum ratings $P_{D(max)} = 700\ mW$, $V_{CE(max)} 15\ V$, and $I_{C(max)} = 100\ mA$

1 1 Determine the maximum value to which V_{CC} can be adjusted without exceeding a rating (7)

1 2 Which rating would be exceeded first? (5)

[12]

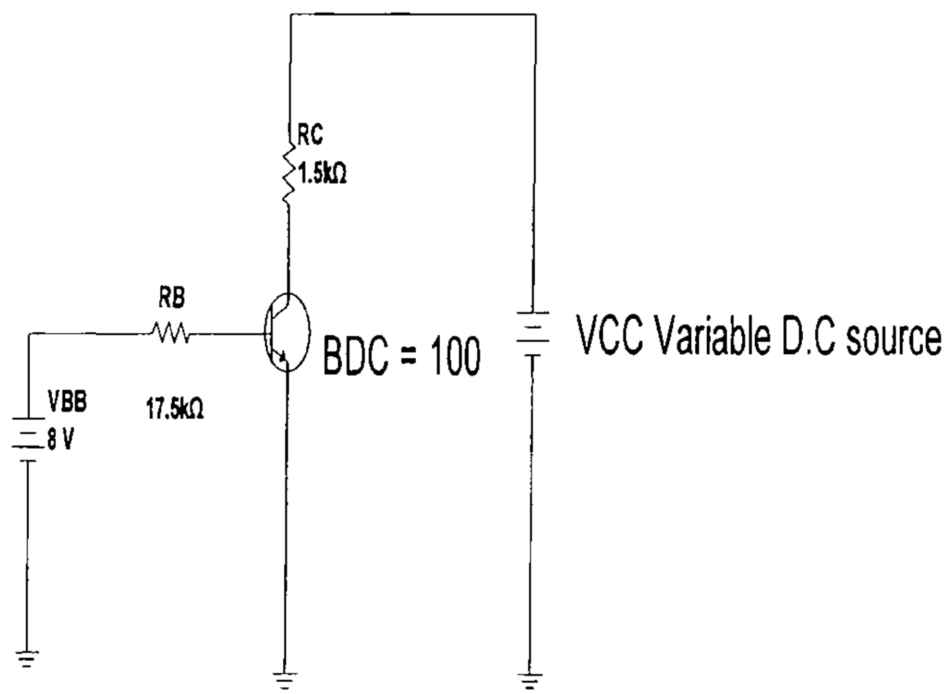


Figure 1

QUESTION 2

Determine whether or not the transistor in figure 2 is in saturation Assume $V_{CE(sat)} = 0\ 3\ V$ (8)

[8]

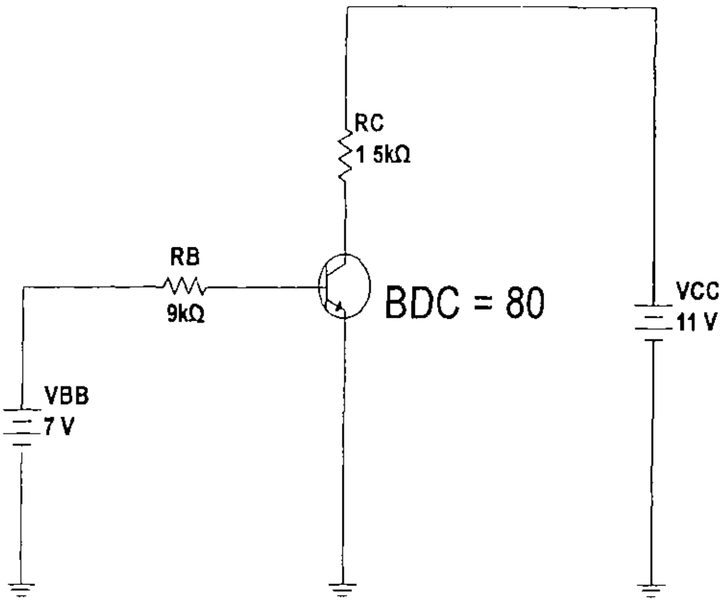


Figure 2

TRANSISTOR BIAS CIRCUITS

QUESTION 3

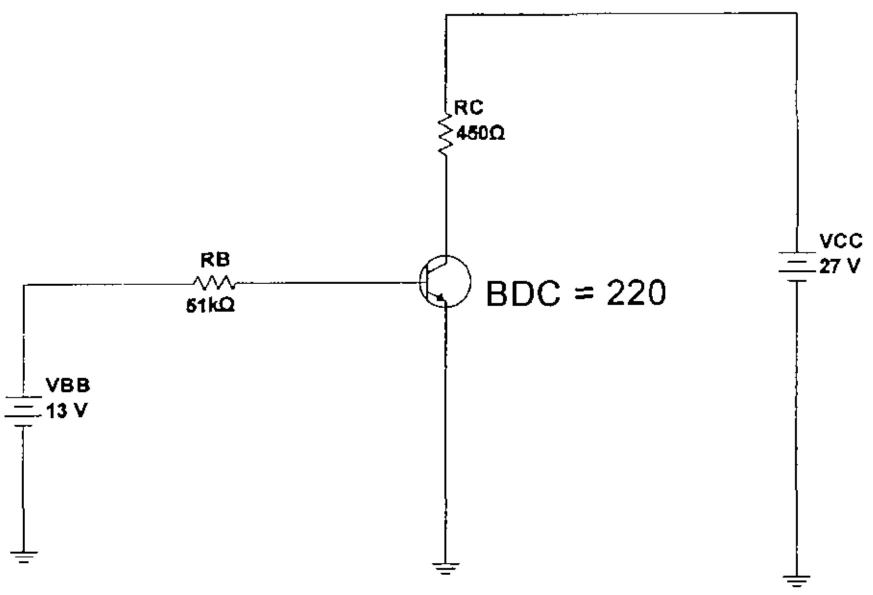


Figure 3

Determine the Q-point for the circuit above in figure 3

3 1 Calculate I_{CQ} and V_{CEQ} (6)

3 2 Find the maximum peak variation of the I_C (Assume $V_{CE(SAT)}$ = 0 2 V) (4)

3 3 Calculate the maximum peak variation of the base current (2)

[12]

QUESTION 4

For the transistor circuit in figure 4 calculate the following,

4 1 I_C (6)

4 2 V_{CE} (4)

[10]

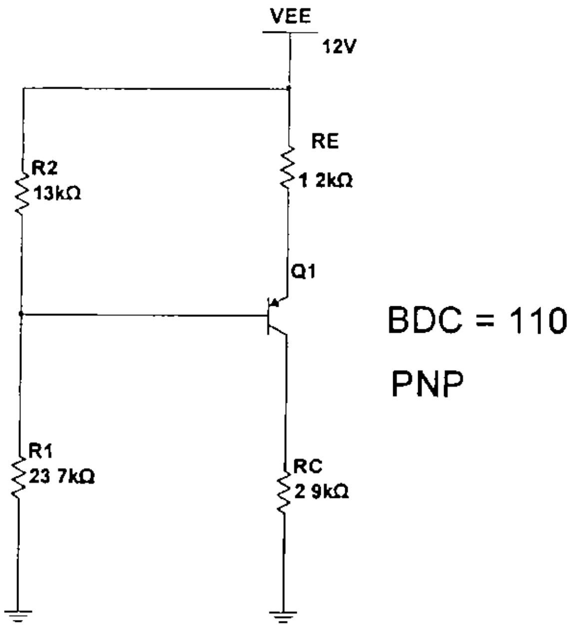


Figure 4

QUESTION 5

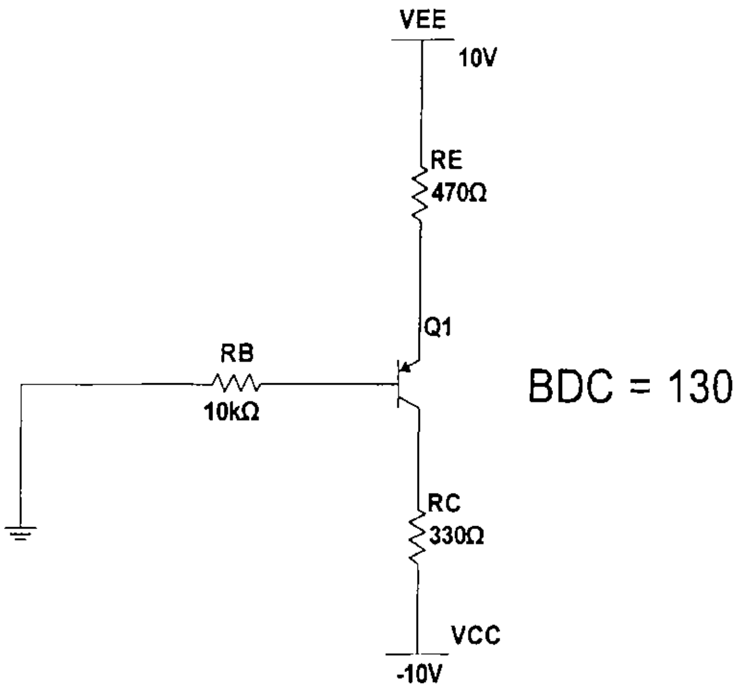


Figure 5

For the emitter bias circuit in figure 5 above

5 1 Calculate the I_E (4)

5 2 Calculate the V_{CE} (4)

[8]

[TURN OVER]

BJT AMPLIFIERS

QUESTION 6

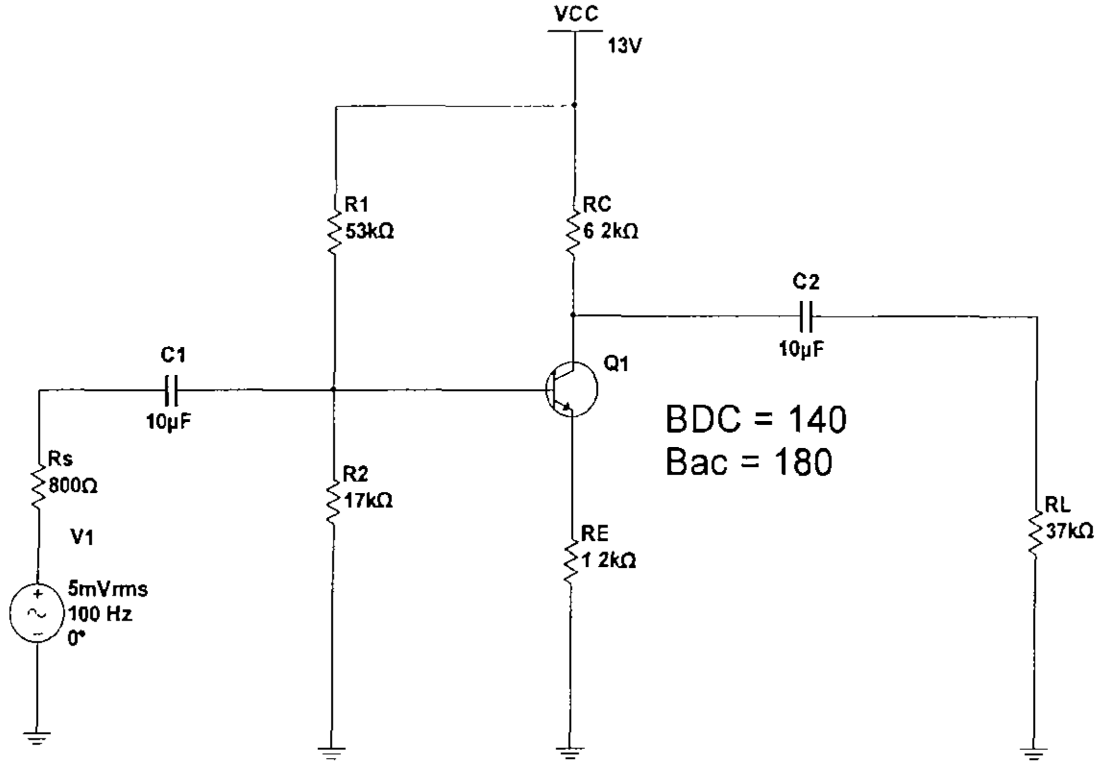


Figure 6

6 1 Determine all the d c values for the circuit in figure 6 above namely,

6 1 1 I_E (6)

6 1 2 V_E (2)

6 1 3 V_B (2)

6.1 4 V_C (2)

6 2 Determine all the a c values for the circuit in figure 6 above namely,

6.2 1 r_e' (2)

6 2 2 $R_{in(base)}$ (2)

6 2 3 $R_{in(tot)}$ (2)

[TURN OVER]

6 2 4 $Attenuation$ (2)

6 2 5 $Gain\ (A_V)$ (2)

6 2 6 $Overall\ Gain$ (2)

6 2 7 $ac\ collector\ voltage\ on\ the\ output$ (2)

[26]

QUESTION 7

For the common-base amplifier circuit in figure 7 below calculate,

7 1 I_E (6)

7 2 R_{in} (2)

7 3 A_V (2)

7 4 A_i (2)

7 5 A_p (2)

7 6 $output\ a\ c\ voltage$ if the input voltage is 1 mV as can be seen in figure 7 (2)

[16]

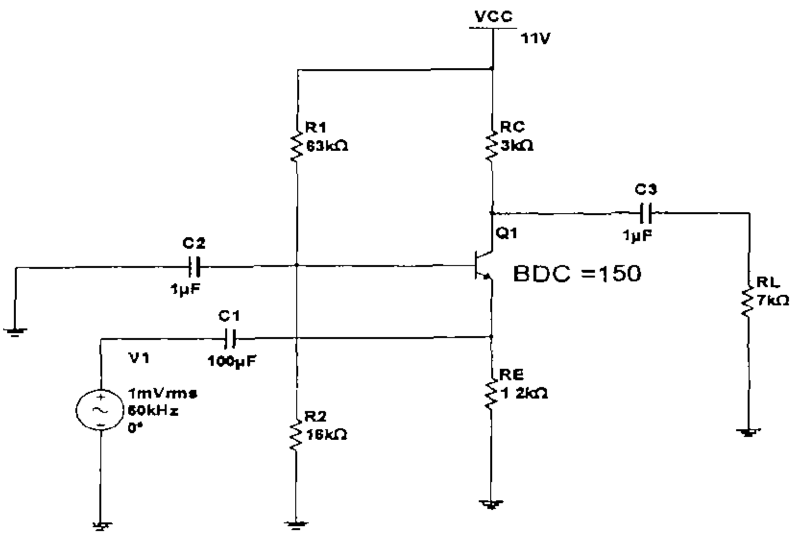


Figure 7

FIELD EFFECT TRANSISTORS

QUESTION 8

For the JFET circuit in figure 8 below given that V_D calculate,

8 1 I_D (4)

8 2 V_{GS} (4)
[8]

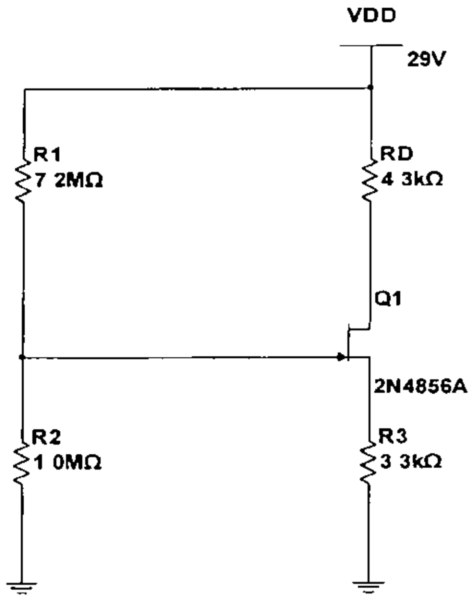


Figure 8

Total: 100

Formula Sheet

$V_{RIP(p-p)} = \left(\frac{V_{DC}}{2fCR_l}\right)$

$V_{RIP(p-p)} = \left(\frac{V_{DC}}{CfR_l}\right)$

$X_C = \frac{1}{2\pi fC}$

$V_{DC} = V_{pk} - \frac{1}{2}V_{RIP(p-p)}$

$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1)R_F}$

$V_{TH} = V_{CC}\left(\frac{R_{B2}}{R_{B1} + R_{B2}}\right)$

$\frac{V_{sec}}{V_{pri}} = \frac{N_{sec}}{N_{pri}}$

$\frac{I_{pri}}{I_{sec}} = \frac{N_{sec}}{N_{pri}}$

$r = \left(\frac{V_r}{V_{DC}}\right)$

$I_{B(min)} = \frac{I_{C(sat)}}{\beta_{DC}}$

$R_{TH} = \left(\frac{R_{B1} \times R_{B2}}{R_{B1} + R_{B2}}\right)$

$V_B \cong \left(\frac{R_2}{R_1 + R_2}\right)V_{CC}$

$A_v \cong \frac{R_C}{R_E}$

$A_v = \frac{R_C}{r'_e}$

$I_{ZM} = \frac{P_{D(max)}}{V_Z}$

$R_{in} = R_G \left\| \left(\frac{V_{GS}}{I_{GSS}}\right)\right.$

$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)^2$

$V_B = \left(\frac{R_2 \| \beta_{DC} R_E}{R_1 + (R_2 \| \beta_{DC} R_E)}\right)V_{CC}$

$V_r = \left(\frac{1}{fR_l C}\right)V_{p(rect)}$

$V_{DC} = \left(1 - \frac{1}{2fR_L C}\right)V_{p(rect)}$

$R_{surge} = \frac{V_{p(sec)} - 1.4V}{I_{FSM}}$

$Z_Z = \frac{\Delta V_Z}{\Delta I_Z}$

$V_{AVG} = \frac{V_p}{\pi}$

$\beta_{DC} = \frac{\alpha_{DC}}{1 - \alpha_{DC}}$

$r'_c = \frac{h_{re} + 1}{h_{oe}}$

$r'_b = h_{ie} - \frac{h_{re}}{h_{oe}}(1 + h_{fe})$

$r'_e \cong \frac{25mV}{I_E}$

$A'_v = \left(\frac{V_b}{V_s}\right)A_v$

$A_v = \frac{R_C}{r'_e + R_E}$

$A_i = \frac{I_c}{I_s}$

$g_m = g_{m0}\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)$

$g_{m0} = \frac{2I_{DSS}}{|V_{GS(off)}|}$

$R_{in} = \left|\frac{V_{GS}}{I_{GSS}}\right|$

$V_G = \left(\frac{R_2}{R_1 + R_2}\right)V_{DD}$

$I_D = \frac{V_G - V_{GS}}{R_S}$

$A_v = \frac{V_{ds}}{V_{gs}}$

Rs = $\left|\frac{V_{GS}}{I_D}\right|$ Av = gm $\left(\frac{R_d r'_{ds}}{R_d + r'_{ds}}\right)$ Av = $\frac{g_m R_d}{1+g_m R_s}$

ID = $\frac{I_{DSS}}{2}$ ID = IDSS $\left(1-\frac{I_D R_S}{V_{GS(off)}}\right)^2$ $f=\frac{1}{T}$

$A_{cl(NI)} = 1+\frac{R_f}{R_i}$ $V_{LTP} = \frac{R_2}{R_1+R_2}(-V_{out(\max)})$ $A_{cl(I)} = -\frac{R_f}{R_i}$

$V_{out} = -\left(\frac{V_C}{t}\right)R_f C$ $\frac{\Delta V_{out}}{\Delta t} = -\frac{V_{in}}{R_i C}$ $V_{UTP} = \frac{R_2}{R_1+R_2}(+V_{out(\max)})$

$F=\frac{kQ_1Q_2}{d_2}$ $V_x = \left(\frac{C_T}{C_X}\right)V_S$ $L=\frac{N^2\mu A}{l}$

$V_{OUT} = V_{REF}(1+\frac{R_2}{R_1}) + I_{ADJ}R_2$ $L_M = k\sqrt{L_1L_2}$ $\frac{1}{L_T} = \frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+ \quad \frac{1}{L_n}$

Percent load regulation = $\frac{V_{NL}-V_{FL}}{V_{FL}} \times 100\%$ Percent line regulation = $\frac{\Delta V_{OUT}}{\Delta V_{IN}} \times 100\%$

$V_{OUT} = -\frac{R_f}{R}(V_{IN1}+V_{IN2}+ \quad +V_{INn})$ $V_{OUT} = -\left(\frac{R_f}{R_1}V_{IN1}+\frac{R_f}{R_2}V_{IN2}+ \quad +\frac{R_f}{R_n}V_{INn}\right)$

$\%distortion_{NEW} = \%distortion_{ORIGINAL}/[1 + (\beta*A)]$ $Z_{OUT}(new) = Z_{OUT}(original)/[1 + (\beta*A)]$

$Z_{OUT}(new) = Z_{OUT}(original) * [1 + (\beta*A)]$ $Z_{IN}(new) = Z_{in}(original) * [1 + (\beta*A)]$

$Z_{IN}(new) = Z_{IN}(original)/[1 + (\beta*A)]$ $f_0 = 1/[2\pi*\sqrt{(L*C)}]$

Modulation depth = [(signal peak)/(carrier peak)]*100% BW = LSB + USB

$A_d = -[(h_{fe}*R_C)/\{2*(R_b + h_{ie})\}]$ $BW_{NEW} = BW_{ORIGINAL} + [1 + (\beta*A)]$

$A_V(dB) = A_{V1}(dB) + A_{V2}(dB) + \quad +A_{Vn}(dB)$ $A'_V = A_{V1}A_{V2}A_{V3} \quad A_{Vn}$

$A_P = \beta_{DC}A_V$ $fr = 1/2\pi\sqrt{LC}$

$V_{DS} = V_{DD} - I_{DSS}R_D$ $P_{out} = V_{rms(out)}I_{rms(out)}$ $eff = P_{OUT}/P_{OUT} + P_{D(AVG)}$

$V_b = h_{ie}I_B$ $\beta = \beta_1\beta_2$ $V_b = V_c h_{re}$

$I_c = I_b h_{fe}$ $I_c = V_c h_{oe}$ $h_{re} = h_{oe}r'_e$

$P_{D(derated)} = P_{D(max)} - (mW/C°)\Delta T$

$R_{in(base)} = \beta_{ac} r'_e$

$R_{in(tot)} = R_1//R_2//R_{IN(BASE)}$

$R_{in(base)} = \beta_{ac}(r'_e + R_{E1})$

$A_p = A'_v A_i$

$A_v\ (db) = 20 \log A_v$

$V_{GS} = -I_D R_S$

$I_d = g_m V_{gs}$

$A_v = g_m R_d$

$V = I \times R$

$S = V \times I \times Cos\theta$

$dB = 10 Log A_P$

$V_{OUT} = -(V_{IN1} + V_{IN2} + \quad + V_{Inn})$

$A_{cl(VF)} = 1$

$V_{HYS} = V_{UTP} - V_{ITP}$

$V_{DS} = V_{DD} - I_{DSS} R_D$

$R_{IN} \cong \beta_{DC} R_E$

$V_{GS} = + I_D R_S$

$R_{IN(base)} \cong \beta_{DC} R_E$

$Q = 1,6 \times 10^{-19}\ C$

$\Delta V_Z = V_Z \times TC \times \Delta T$

$R_{in} = R_1 \| R_2 \| R_{IN(gate)}$

$A_f = A/[1 + (\beta * A)$

$Z_{IN} = h_{ie} + (h_{fe} + 1)^* r_{e2}$

$F_0 = \sqrt{(f_1 * f_2)}$

$BW = f_2 - f_1$

$Q = f_0/BW$

$f_0 = [1/[(2\pi)^*(\sqrt{((1/L^*C) - (R^2/L^2))}]$

$Q = [\sqrt{L/(C^*R^2)}] - 1$

$R_p = (\omega_0{}^2 {}^* L^2)/R_s$

$R_s = (\omega_0{}^2 {}^* L^2)/R_p$

$Q = (1/R)^* \sqrt{(L/C)}$

$Q_L = (\omega_0 {}^* L)/R_X$

$Q_C = 1/(\omega_0 {}^* C)$

$R_0 = \sqrt{(L/C)}$

$f_C = 1/(\pi^* \sqrt{L^*C})$

$F_C = 1/4\pi^* \sqrt{L^*C})$

$C = C_N/(2\pi^* f_C {}^* R)$

$L = (R^* L_N)/(2\pi^* f_C)$

$A_0 = 3 - P$

$A_0 = (R_1 = R_2)/R_1$

$f_C = 1/(2\pi^* R^* C)$

$L = F^* N^{2*} D$

F = lower point + (Z*(X/Y)

$Z_1 = Z'/(1 - A_V)$

$Z_2 = (Z'^* A_V)/(A_V - 1)$

$A_i = hf/[1 + (h_o {}^* Z_L)]$

$A_V = (A_i/Z_i)^* Z_L$

$Z_i = h_i + (h_r {}^* A_i {}^* Z_L)$

$Y_0 = 1/Z_0 = h_0 - [(h_f {}^* h_r)/(h_i + R_S)]$

$V = IX_C$

$L_T = L_1 + L_2 + L_3 + \quad L_n$

$X_L = 2\pi f L$

$V = IX_L$