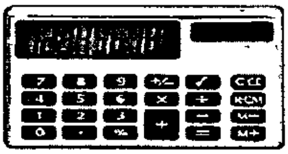
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA university of south africa

ECT2601
RCT2601

May/June 2016

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 4 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

Question 1

The transistor in **Figure 1** has the following maximum ratings $P_{D(\max)} = 500mW$, $V_{CE(\max)} = 25V$, and $I_{C(\max)} = 200mA$

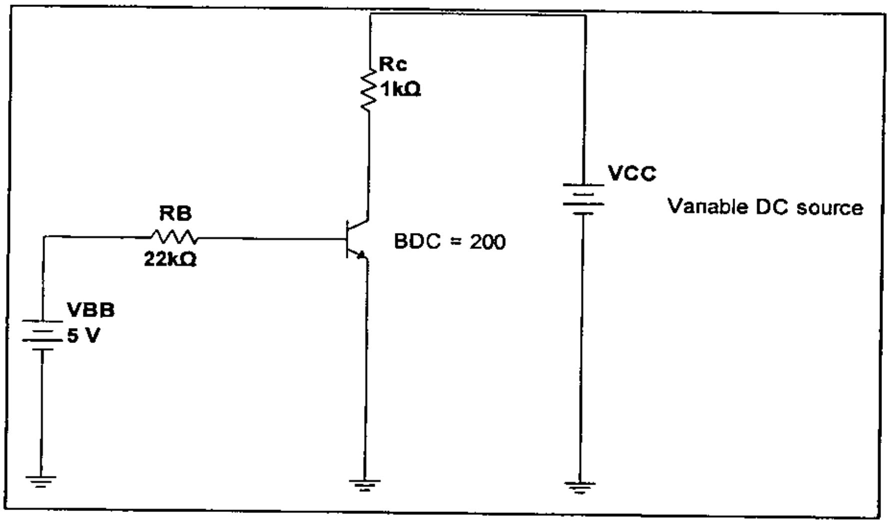


Figure 1

1.1 Determine the maximum value to which V_{CC} can be adjusted without exceeding a rating (8)

1.2 Which rating would be exceeded first? (6)

[14]

[TURN OVER]

Question 2

A transistor has a $P_{D(\max)} = 5W$ at 25°C The derating factor is 7mW/°C What is the $P_{D(\max)}$ at 80°C ? (4)

[4]

Question 3

A 50mV signal is applied to the base of a properly biased transistor with $r_e' = 10\Omega$ and $R_C = 560\Omega$ Determine the signal voltage at the collector (4)

[4]

TRANSISTOR BIAS CIRCUITS

Question 4

Refer to **Figure 2** to answer the following questions

4 1 Determine the Q-point for the circuit in **Figure 2** (6)

4 2 Find the maximum peak value of the base current for linear operation Assume $B_{DC} = 250$ (6)

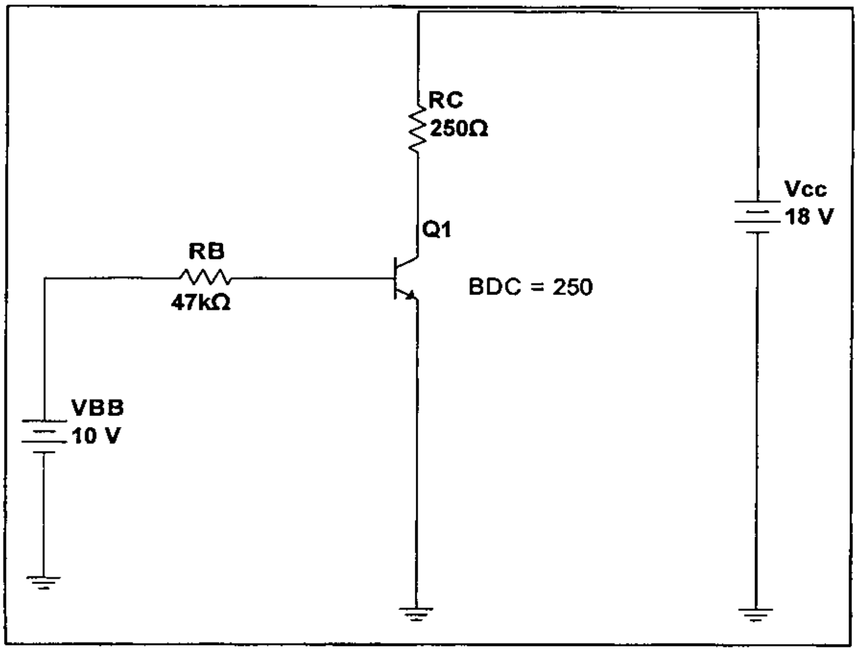


Figure 2

[12]

Question 5

For the circuit in **Figure 3** and

5 1 Determine the Q-point values for the transistor voltage divider circuit (6)

5 2 Determine the minimum power rating of the transistor (2)

5 3 Calculate I_1, I_2 *and* I_B for the circuit in **Figure 3** (8)

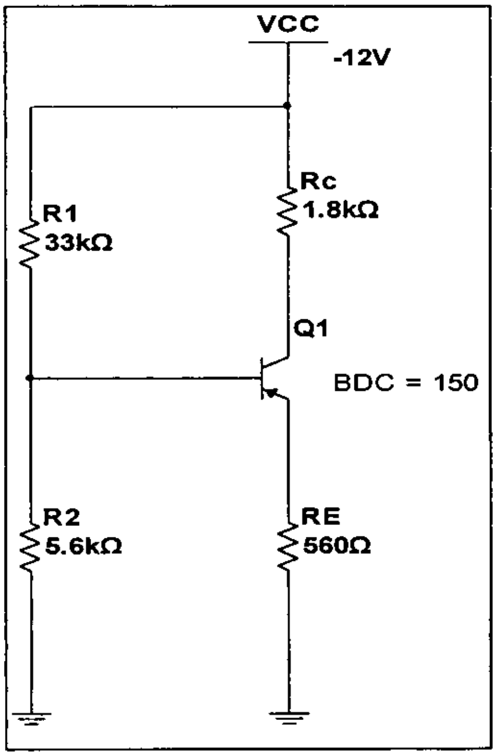


Figure 3

[16]

Question 6

For the emitter bias circuit in **Figure 4**, determine the correct voltages, V_B, V_E, V_C, V_{CE} at the transistor terminals with respect to ground. Assume $B_{DC} = 100$. (10)

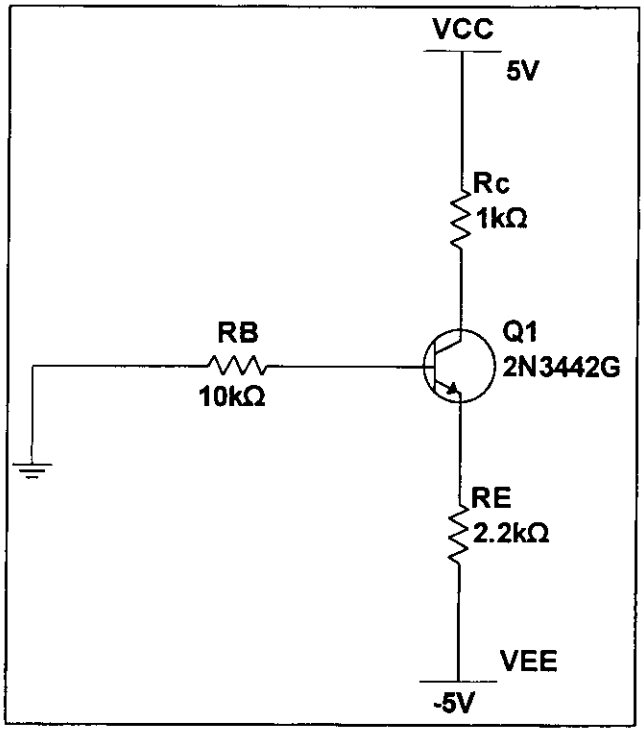


Figure 4

[10]

BJT AMPLIFIERS

Question 7

For the BJT amplifier in **Figure 5**,

7 1 Determine all the dc terminal voltages (10)

7 2 Calculate

7 2 1 r_e' (2)

7 2 2 $R_{in(base)}$ (2)

7 2 3 $R_{in(tot)}$ (2)

7 2 4 *Attenuation* (2)

7 2 5 A_v (Voltage gain) (2)

7 2 6 A'_v (Overall voltage gain) (2)

7 2 7 The ac collector voltage V_c (2)

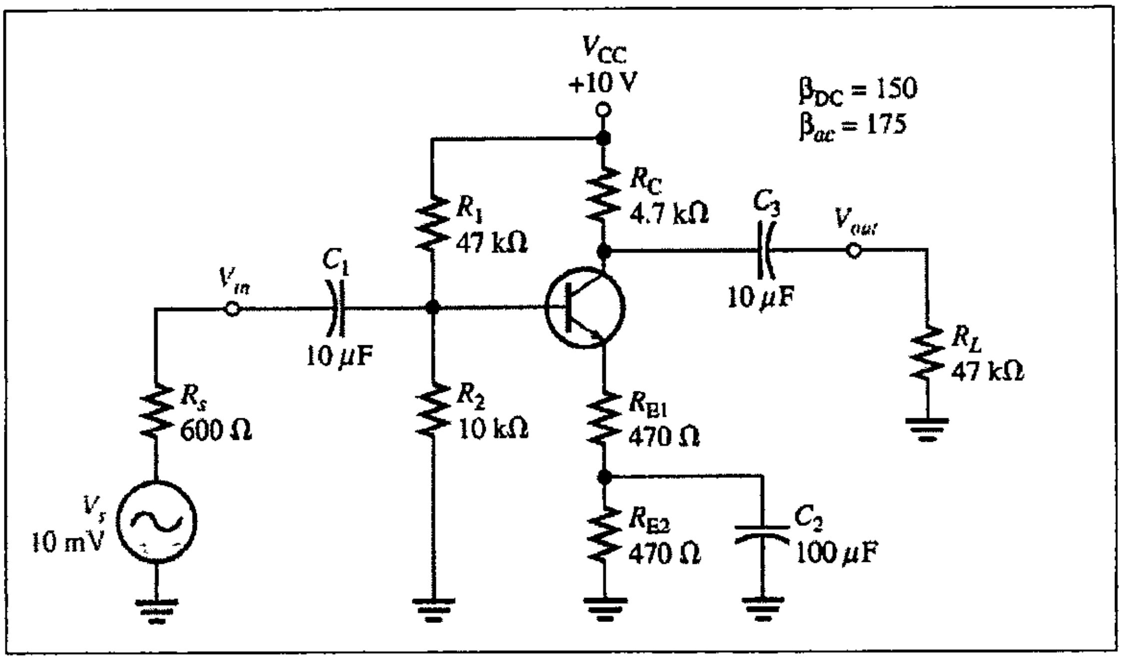


Figure 5

[24]

FIELD–EFFECT TRANSISTORS (FET's)

Question 8

8 1 Determine the Q-point for the JFET with voltage-divider bias in **Figure 6**, given that the device has a transfer characteristic curve shown in **Figure 7** (10)

8 2 Plot the load line unto the transfer characteristic (4)

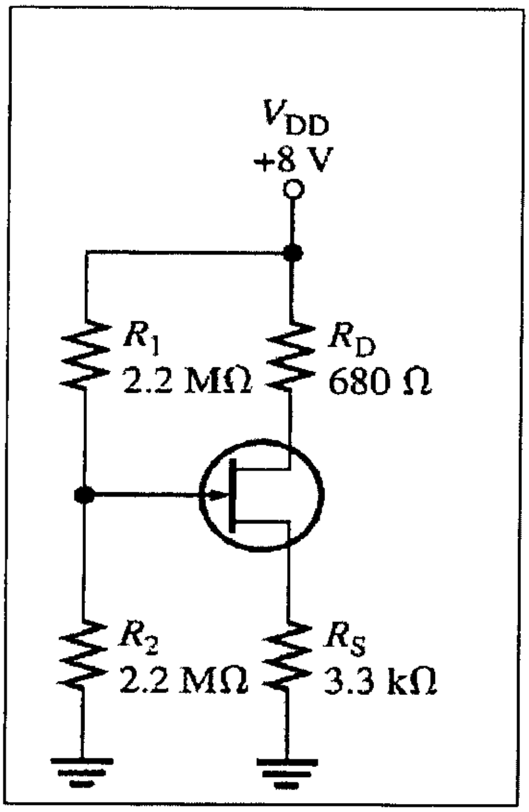


Figure 6

[14]

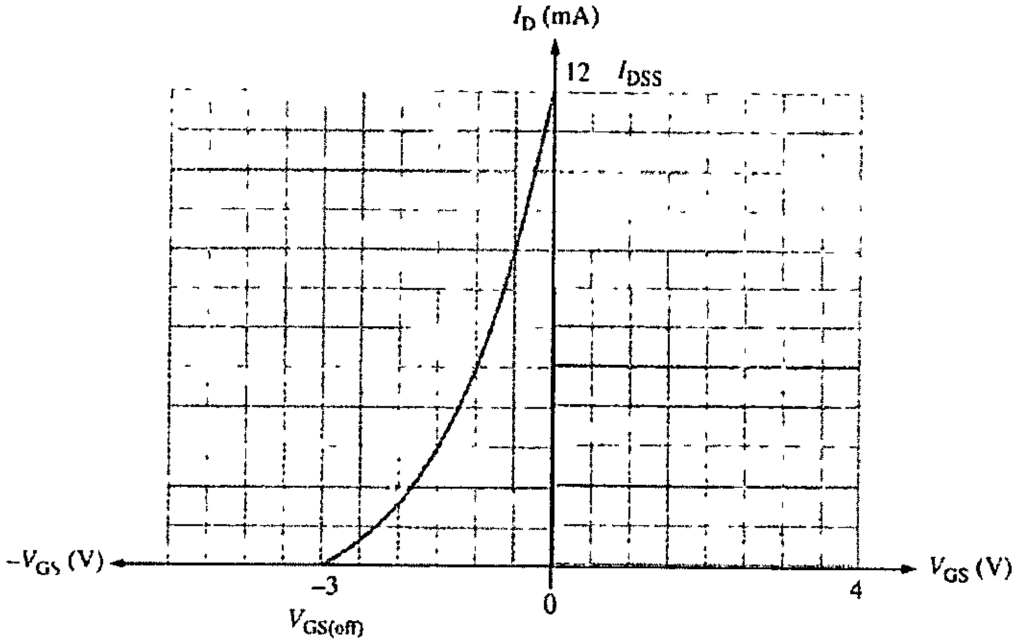


Figure 7

Question 9

True or **False** The JFET is always operated with the gate-source pn junction reverse biased

(2)

[2]

Total Marks [100]

Formula Sheet

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$R_{surge} = \frac{V_{p(sec)} - 1\ 4V}{I_{FSM}}$

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

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

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

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

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

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

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

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

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

gm = gm0$\left(1 - \frac{V_{GS}}{V_{GS(off)}}\right)$

gm0 = $\frac{2I_{DSS}}{|V_{GS(off)}|}$

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

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

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

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

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

$f = \frac{1}{T}$

$A_{cl(NI)} = 1 + \frac{R_f}{R_i}$

$V_{LTP} = \frac{R_2}{R_1 + R_2}(-V_{out(\max)})$

$A_{cl(I)} = -\frac{R_f}{R_i}$

$V_{out} = -\left(\frac{V_C}{t}\right)R_f C$

$\frac{\Delta V_{out}}{\Delta t} = -\frac{V_{in}}{R_i C}$

$V_{UTP} = \frac{R_2}{R_1 + R_2}(+V_{out(\max)})$

$F = \frac{kQ_1Q_2}{d_2}$

$V_x = \left(\frac{C_T}{C_X}\right)V_S$

$L = \frac{N^2 \mu A}{l}$

$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1}) + I_{ADJ}R_2$

$L_M = k\sqrt{L_1 L_2}$

$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \quad \frac{1}{L_n}$

Percent load regulation = $\frac{V_{NL} - V_{FL}}{V_{FL}}$ × 100%

Percent line regulation = $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$ × 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

$A_d = -[(h_{fe}*R_C)/\{2*(R_b + h_{ie})\}]$

$BW_{NEW} = BW_{ORIGINAL} + [1 + (\beta*A)]$

$A_V(dB) = A_{V1}(dB) + A_{V2}(dB) + \quad +A_{Vn}(dB)$

$A'_V = A_{V1}A_{V2}A_{V3} \quad A_{Vn}$

$A_P = \beta_{DC}A_V$

$fr = 1/2\pi\sqrt{LC}$

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

$P_{out} = V_{rms(out)}I_{rms(out)}$

$eff = P_{OUT}/P_{OUT} + P_{D(AVG)}$

$V_b = h_{ie}I_B$

$\beta = \beta_1\beta_2$

$V_b = V_c h_{re}$

$I_c = I_b h_{fe}$

$I_c = V_c h_{oe}$

$h_{re} = h_{oe}r'_e$

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

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

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

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

$A_p = A'_v A_i$

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

$V_{GS} = -I_D R_S$

$I_d = g_m V_{gs}$

$A_v = g_m R_d$

$V = I \times R$

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

$dB = 10 Log A_P$

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

$A_{cl(VF)} = 1$

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

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

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

$V_{GS} = + I_D R_S$

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

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

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

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

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

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

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

$BW = f_2 - f_1$

$Q = f_0/BW$

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

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

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

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

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

$Q_L = (\omega_0*L)/R_X$

$Q_C = 1/(\omega_0 * C)$	$R_0 = \sqrt{(L/C)}$	$f_C = 1/(\pi * \sqrt{L} * C)$
$F_C = 1/4\pi * \sqrt{L} * C)$	$C = C_N/(2\pi * f_C * R)$	$L = (R * L_N)/(2\pi * f_C)$
$A_0 = 3 - P$	$A_0 = (R_1 = R_2)/R_1$	$f_C = 1/(2\pi * R * C)$
$L = F * N^2 * D$	$F = \text{lower point} + (Z * (X/Y)$	$Z_1 = Z^{/}/(1 - A_V)$
$Z_2 = (Z^{/} * A_V)/(A_V - 1)$	$A_i = hf/[1 + (h_o * Z_L)]$	$A_V = (A_i/Z_i) * Z_L$
$Z_i = h_i + (h_r * A_i * Z_L)$	$Y_0 = 1/Z_0 = h_0 - [(h_f * h_r)/(h_i + R_S)]$	$V = IX_C$
$L_T = L_1 + L_2 + L_3 + \quad L_n$	$X_L = 2\pi fL$	$V = IX_L$