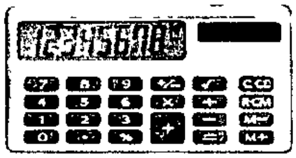
UNIVERSITY EXAMINATIONS



UNIVERSITEITSEKSAMENS

UNISA university of south africa

ECT2601
RCT2601

May/June 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

QUESTION 1

Determine emitter current and the terminal voltages of the transistor with respect to ground for the circuit in figure 1

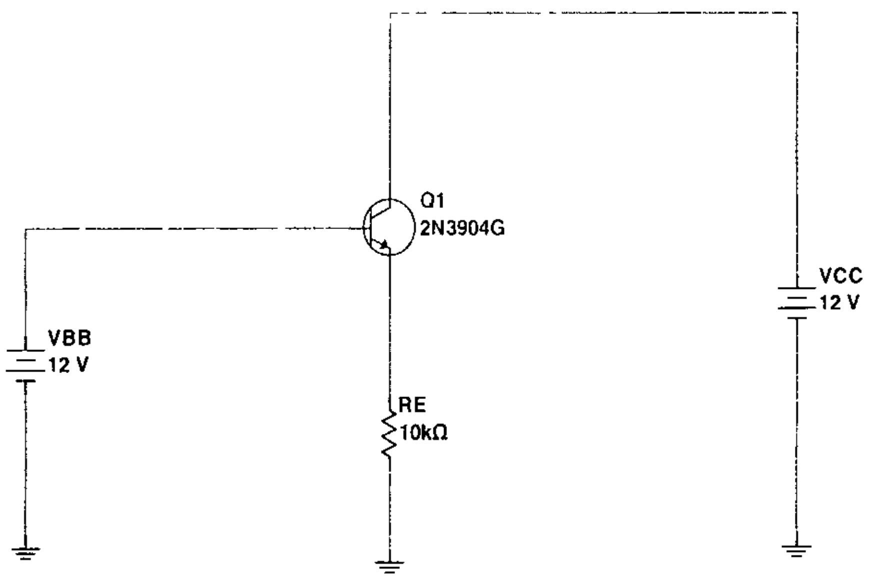


Figure 1

1 1 I_E (2)
1 2 V_E (2)
1 3 V_C (2)
1 4 V_{CE} (2)
1 5 V_{CB} (2)

[10]

TRANSISTOR BIAS CIRCUITS

QUESTION 2

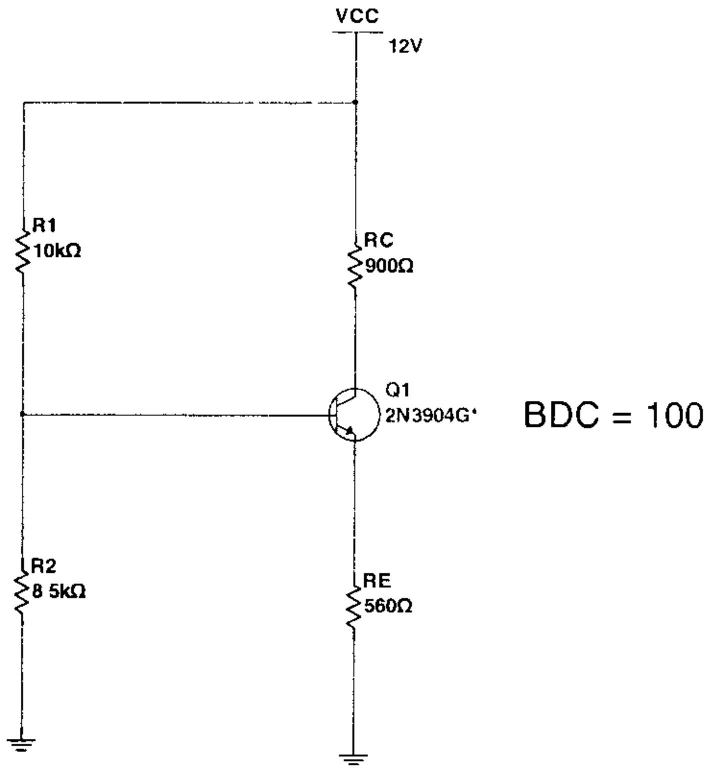


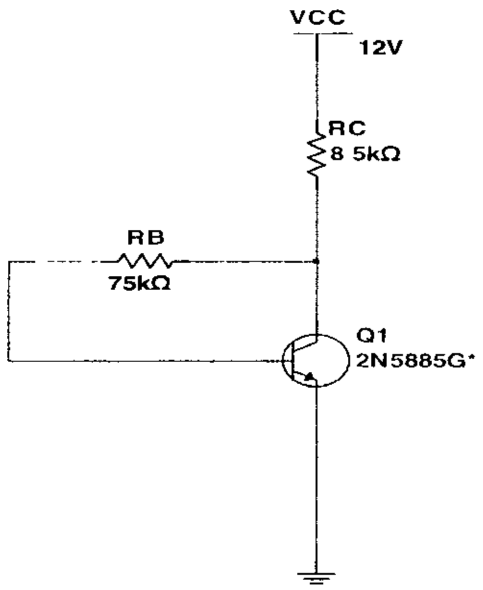
Figure 2

Calculate for figure 2 above

2 1	V_{TH}	(2)
2.2	R_{TH}	(2)
2 3	I_E	(2)
2.4	V_{CE}	(2)
		[8]

[TURN OVER]

QUESTION 4



BDC = 200

Figure 4

For figure 4, calculate the value of

4 1 I_C (3)

4 2 V_C (3)

4 3 V_{CE} (2)

[8]

[TURN OVER]

BJT AMPLIFERS

QUESTION 5

For the BJT amplifier in figure 5 determine the

5 1 V_{TH} (2)

5 2 R_{TH} (2)

5 3 I_E (2)

5 4 r'_e (2)

5 5 $B_{ac}r'_e$ (2)

5 6 $r_{in}(tot)$ (2)

5 7 A_{tt} (2)

5 8 A_v (2)

5 9 $overall\ A_v$ (2)

5 10 $output\ a\ c\ voltage$ (2)

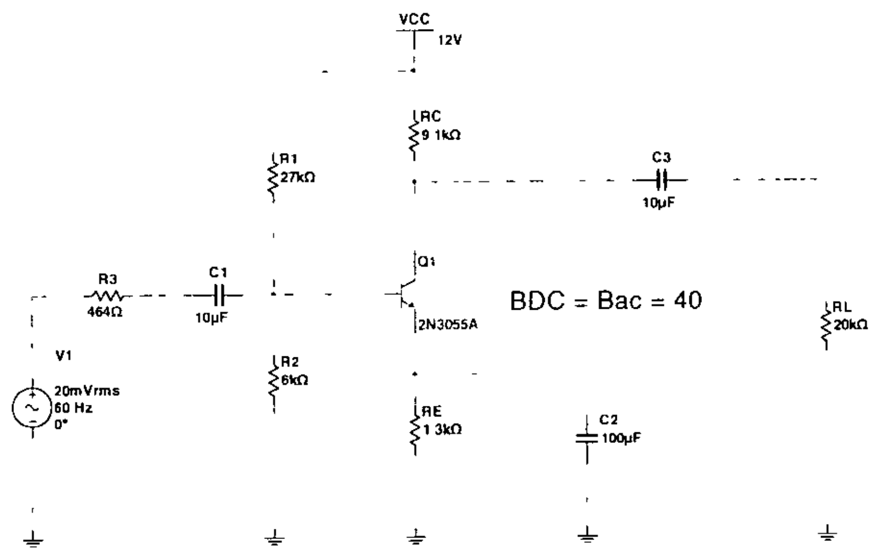


Figure 5

[20]

[TURN OVER]

QUESTION 6

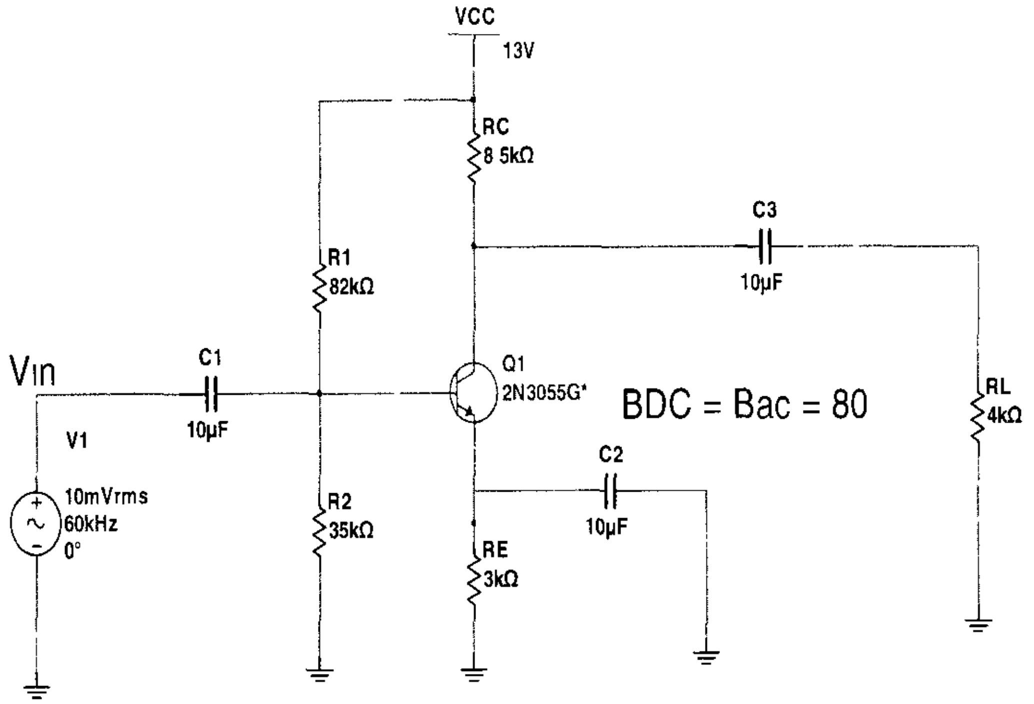


Figure 6

Calculate

6 1	V_{TH}	(2)
6 2	R_{TH}	(2)
6 3	I_E	(2)
6 4	r'_e	(2)
6 5	$B_{ac}r_e$	(2)
6 6	$r_{in}(tot)$	(2)
6 7	A_V	(2)
6 8	$Output\ a\ c\ voltage$	(2)

[16]

[TURN OVER]

FIELD EFFECT TRANSISTORS

QUESTION 7

The partial datasheet for a 2N5459 JFET indicates that typically $I_{DSS} = 8mA$ and $V_{GS(off)} = -6V$ (maximum) Using these values, determine the drain current for $V_{GS} = 0V, -3V, -6V$ **[6]**

QUESTION 8

Determine I_D and V_{GS} for the JFET with a voltage-divider bias in figure 7, given that for this particular JFET the parameter values are such that $V_D = 8V$ **[10]**

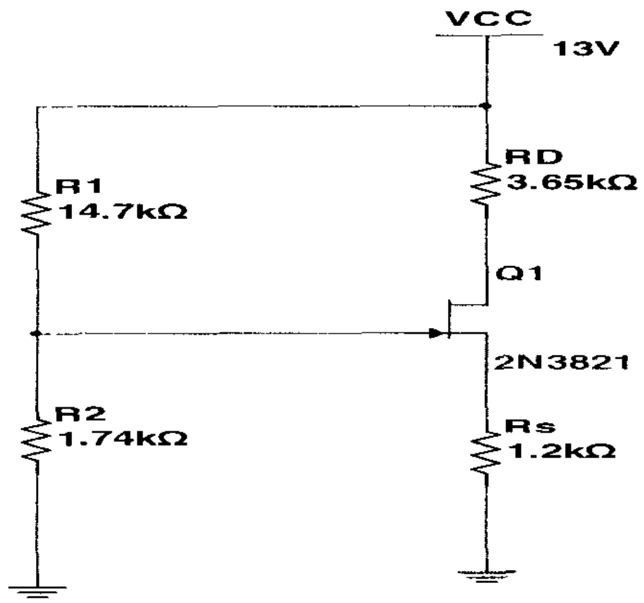


Figure 7

QUESTION 9

Find V_{DS} and V_{GS} in figure 8 below

The parameter values for the self-biased JFET are such that I_D of approximately 3mA is produced **[12]**

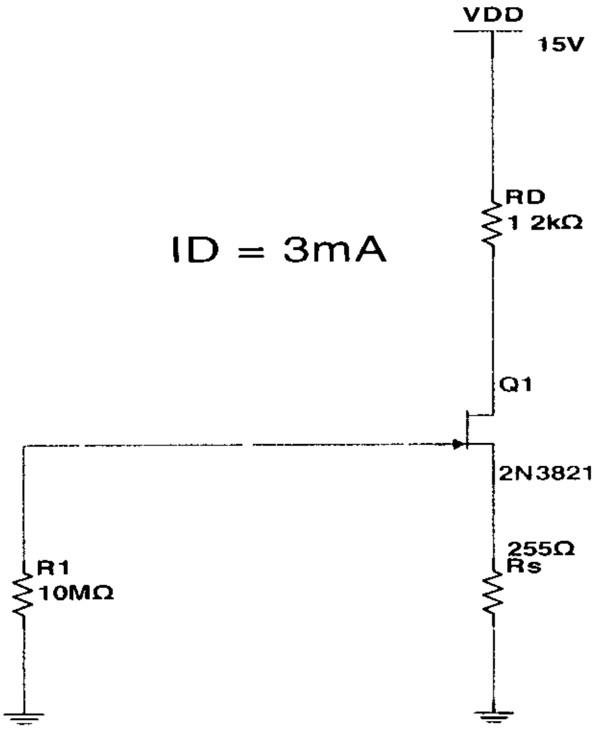


Figure 8

TOTAL MARKS: 100

Formula Sheet

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$V_r = \left(\dfrac{1}{fR_L C}\right)V_{p(rect)}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$V_G = \left(\frac{R_2}{R_1 + R_2}\right)V_{DD}$ $I_D = \frac{V_G - V_{GS}}{R_S}$ $A_v = \frac{V_{ds}}{V_{gs}}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$P_{D(derated)} = P_{D(max)} - (mW/C°)\Delta T$ $R_{in(base)} = \beta_{ac}r'_e$ $R_{in(tot)} = R_1//R_2//R_{IN(BASE)}$

$R_{in(base)} = \beta_{ac}(r'_e + R_{E1})$ $A_p = A'_vA_i$ $A_v\ (db) = 20 \log A_v$

$V_{GS} = -I_DR_S$ $I_d = g_mV_{gs}$ $A_v = g_mR_d$

$V = I \times R$ $S = V \times I \times Cos\theta$ $dB = 10LogA_P$

$V_{OUT} = -(V_{IN1} + V_{IN2} + \quad +V_{Inn})$ $A_{cl(VF)} = 1$ $V_{HYS} = V_{UTP} - V_{ITP}$

$V_{DS} = V_{DD} - I_{DSS}R_D$ $R_{IN} \cong \beta_{DC}R_E$ $V_{GS} = +I_DR_S$

$R_{IN(base)} \cong \beta_{DC}R_E$ $Q = 1{,}6 \times 10^{-19}\ C$ $\Delta V_Z = V_Z \times TC \times \Delta T$

$R_{in} = R_1 \| R_2 \| R_{IN(gate)}$ $A_f = A/[1 + (\beta \times A)$ $Z_{IN} = h_{ie} + (h_{fe} + 1)^* r_{e2}$

$F_0 = \sqrt{(f_1 * f_2)}$ $BW = f_2 - f_1$ $Q = f_0/BW$

$f_0 = [1/[(2\pi)^*(\sqrt{((1/L^*C) - (R^2/L^2))}]$ $Q = [\sqrt{L/(C^*R^2)}] - 1$ $R_p = (\omega_0{}^2 {}^* L^2)/R_s$

$R_s = (\omega_0{}^2 {}^* L^2)/R_p$ $Q = (1/R)^* \sqrt{(L/C)}$ $Q_L = (\omega_0{}^*L)/R_X$

$Q_C = 1/(\omega_0{}^*C)$ $R_0 = \sqrt{(L/C)}$ $f_C = 1/(\pi^*\sqrt{L^*C})$

$F_C = 1/4\pi^*\sqrt{L^*C})$ $C = C_N/(2\pi^*f_C{}^*R)$ $L = (R^*L_N)/(2\pi^*f_C)$

$A_0 = 3 - P$ $A_0 = (R_1 = R_2)/R_1$ $f_C = 1/(2\pi^*R^*C)$

$L = F^*N^2{}^*D$ $F = \text{lower point} + (Z^*(X/Y)$ $Z_1 = Z'/(1 - A_V)$

$Z_2 = (Z'^*A_V)/(A_V - 1)$ $A_i = hf/[1 + (h_0{}^*Z_L)]$ $A_V = (A_i/Z_i)^*Z_L$

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

$L_T = L_1 + L_2 + L_3 + \quad L_n$ $X_L = 2\pi fL$ $V = IX_L$