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NAME	memo
STUDENT NUMBER	

FORMATIVE ASSESSMENT 1 SEMESTER 2 2022

SUBJECT: ELECTRONICS II
SUBJECT CODE: ELC211B/EL2116D/EL2F06D

PAPER DESCRIPTION: CLOSED BOOK
DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

Fill in the answers into the blocks provided. Do not do calculations inside blocks intended for answers. You may be penalized for untidy work. Answers will not be marked unless correct units are given. All silicon junction voltages are 0,7 V in forward bias. Answers must be accurate to the first three significant figures.

NUMBER OF PAGES: 5
NUMBER OF QUESTIONS: 4
APPENDICES: 0

EXAMINERS: MR T D MATSHIBA
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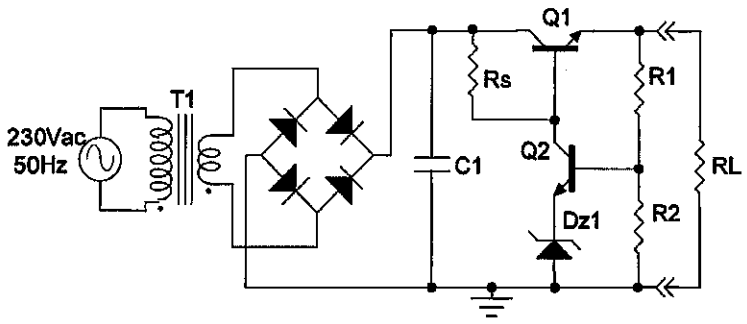
MODERATOR: MRS Z MAHLOBOGWANE

TOTAL MARK: 47 **FULL MARK 40**

QUESTION 1 (10)



Load current through RL: 200mA
V_{DC} (across C1) = 200 V
Rs = 3300 Ω
C1= 470μF
R1 = 62 kΩ, R2 = 2200 Ω
Dz1 = 5.1 V
β(Q1) = 110
β(Q2) = LARGE (Ignore $I_{B(Q2)}$)

Answer the following for the circuit given:

(a) The purpose of the circuit is to provide a constant voltage across RL while the voltage across C1 may vary. Which component in the circuit is used as error amplifier to counteract changes in the output voltage?	**Component label:** Q2
(b) Explain the purpose of the following components: T1: Isolation STEP DOWN STEP UP	
C1: FILTER.	

(c) Calculate and fill in the following for the circuit given:		**V(RL):** 169,254V
I_{RS}: 9,105 mA	**$I_{C(Q2)}$:** 0,811 mA	**$I_{C(Q1)}$:** 200,81 mA
P(R1): 430,807mW	**P(R2):** 15,289 mW	**P(Q1):** 6,174 W

QUESTION 1

① $V_{R_L} = V_{R_2} \frac{R_1 + R_2}{R_2}$

② $V_{R_2} = V_{BE_{Q_2}} + V_{Z_1}$
$= 0,7 + 5.1$
$= 5,8\,V$

③ $V_{R_L} = V_{R_2} \frac{R_1 + R_2}{R_2}$
$= 5.8 \frac{62K + 2,2K}{2,2K}$
$= 169,254\,V$

④ $I_{R_1} = I_{R_2} = \frac{V_{R_2}}{R_2}$
$= \frac{5,8}{2,2}$
$= 2,636\,mA$

⑤ $V_{C1} = V_{R_S} + V_{BE_{Q_1}} + V_{RL}$
$200 = V_{R_S} + 0,7 + 169,254$
$V_{R_S} = 30,046\,V$

⑥ $I_{R_S} = \frac{V_{R_S}}{R_S} = \frac{30,046}{3300}$
$= 9,105\,mA$

⑦ $I_{E_{Q_1}} = I_{R_1} + I_{R_L}$
$= 2,636m + 200m$
$= 202,636\,mA$

⑧ $I_{B_{Q_1}} = \frac{I_{E_{Q1}}}{\beta_{Q_1} + 1}$
$= \frac{202,636m}{110+1}$
$= 1,825\,mA$

⑨ $I_{C_{Q_1}} = \frac{\beta_{Q_1} I_{E_{Q_1}}}{\beta_{Q_1} + 1}$
$= \frac{110 \times 202,636\,m}{110+1}$
$= 200,81\,mA$

⑩ $I_{R_S} = I_{B_{Q_1}} + I_{C_{Q_2}}$
$2,636m = 1,825m + I_{C_{Q_2}}$
$I_{C_{Q_2}} = 0,811\,mA.$

⑪ $I_{C_{Q_2}} = I_{E_{Q_2}} = I_{Z_1}$
$= 0,811\,mA$

⑫ $V_{R_1} = I_{R_1} R_1$
$= 2,636m \times 62K$
$= 163,432\,V$

⑬ $P_{R_1} = V_{R_1} I_{R_1}$
$= 163,432 \times 2,636\,m$
$= 430,807\,mW$

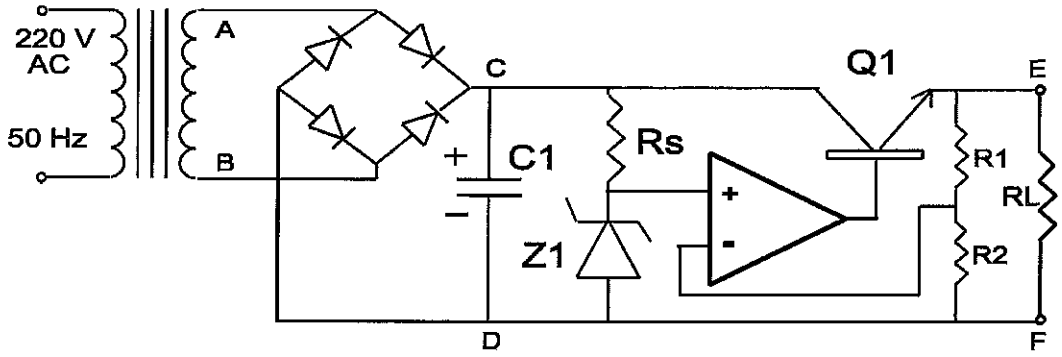
⑭ $P_{R_2} = V_{R_2} I_{R_2}$
$= 5,8 \times 2,636\,m$
$= 15,289\,mW$

⑮ $V_{C_1} = V_{CE_{Q_1}} + V_{RL}$
$200 = V_{CE_{Q_1}} + 169,254$
$V_{CE_{Q_1}} = 30,746\,V$

⑯ $P_{Q_1} = V_{CE_{Q_1}} I_{C_{Q_1}}$
$= 30,746 \times 200,81m$
$= 6,174\,W.$

QUESTION 2 (16)

Given: Load current through RL: 600 mA The Op Amp is a TL071 (same pins as a 741)



The supply terminals (Pin 4 and 7) of the Op Amp is connected to D and C
Use Vr(p-p) = I/CF when calculating ripple voltage

V_{C1} = 18 V_{DC} Rs = 2200Ω R1 = 470Ω R2 = 1000Ω C1= 2200µF

Z1 = 5,6V/ 1W β_{Q1} = 90 ~~Z1= 9 V (1Watt Rated)~~

Fill in:

The voltage across RL: (2) 8,232 V		The voltage across R1: (2) 2,632 V
The emitter current ($I_{E(Q1)}$) : (2) 605,6 mA		The current at the output of the Op Amp: (2) 6,655 mA
$V_{CE(Q1)}$: (2) 9,768 V		The peak-to-peak ripple voltage across C1: (2) 2,778 V **(Include Zener and R1 current)**
By making R1 adjustable, the output could be adjustable:		
What is the minimum output voltage if R1 is an adjustable 470Ω? (2) 5,6 V		What is the maximum output voltage if R1 is an adjustable 470Ω? (2) 8,232V

QUESTION 2

① $V_{R_2} = V_{Z_1} = 5,6\,V$

② $I_{R_1} = I_{R_2} = \frac{V_{R_2}}{R_2} = \frac{5,6}{1000}$

$= 5,6\,mA$

③ $V_{R_L} = V_{R_2} \frac{R_1 + R_2}{R_2}$

$= 5,6 \frac{470 + 1000}{1000}$

$= 8,232\,V$

④ $I_{EQ_1} = I_{R_1} + I_{R_L}$

$= 5,6m + 600m$

$= 605,6\,mA$

⑤ $V_{R_1} = I_{R_1} R_1$

$= 5,6m \times 470$

$= 2,632\,V$

⑥ $V_{C_1} = V_{CEQ_1} + V_{RL}$

$18 = V_{CEQ_1} + 8,232$

$V_{CEQ_1} = 9,768\,V$

⑦ $I_{BQ_1} = \frac{I_{EQ_1}}{\beta_{Q_1} + 1}$

$= \frac{605,6m}{90 + 1}$

$= 6,655\,mA$

⑧ $I_{out\,OpAmp} = I_{BQ_1}$

$= 6,655\,mA$

⑨ $V_{R_S} = V_{C_1} - V_{Z_1}$

$= 18 - 5,6$

$= 12,4\,V$

⑩ $I_{R_S} = \frac{V_{R_S}}{R_S} = \frac{12,4}{2200}$

$= 5,636\,mA.$

⑪ $I_{R_S} = I_{Z_1}$

$I_{Z_1} = 5,636\,mA$

⑫ $I_T = I_{Z_1} + I_{EQ_1}$

$= 5,636m + 605,6m$

$= 611,236\,mA$

⑬ $V_{r(P-P)} = \frac{I}{CF} = \frac{611,236 \times 10^{-3}}{2200 \times 10^{-6} \times 100}$

$= 2,778\,V$

⑭ $V_{OUT_{min}} = V_{R_2} \frac{R_{1_{min}} + R_2}{R_2}$

$= 5,6 \frac{0 + 1000}{1000}$

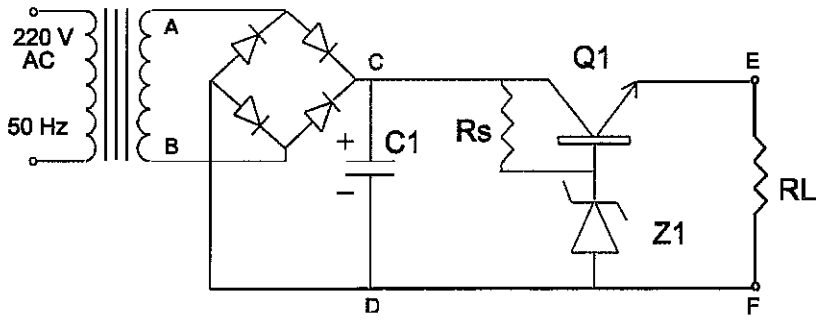
$= 5,6\,V$

⑮ $V_{OUT_{MAX}} = V_{R_2} \frac{R_{1_{MAX}} + R_2}{R_2}$

$= 5,6 \frac{470 + 1000}{1000}$

$= 8,232\,V$

QUESTION 3 (12)



Given:
Load current through RL: 800 mA

Ripple voltage across C1: **Vr(p-p) = I/CF** or **It/C**
(Assume ripple is a triangle wave)

V_{RMS} (AB) = $15V_{RMS}$ Rs = 150 C1= 4700µF

The current through Z1 is 40mA (with load current of 800mA) Z1= 10 V (1 Watt Rated)

Fill in:

The average voltage across the load: 9,3V	The peak-to-peak ripple across C1: 1,787 V (Include I_Z in calculation)
The peak voltage across C1: 19,813V	The average voltage across C1: 18,919V
The current through Rs: 59,46mA	The collector current of Q1: 780,54 mA
The base current of Q1: 19,46mA	The emitter current of (Q1): 800mA
The power wasted in Rs: 530,324mW	The power wasted in Z1: 400mW
The power wasted in Q1: 7,508W (V_{CE} x I_C)	The zener current if the load is disconnected: 59,46mA

QUESTION 3

① $V_{B_{Q_1}} = V_{Z_1} = V_{BE_{Q_1}} + V_{R_L}$

$10 = 0,7 + V_{R_L}$

$V_{R_L} = 9,3\,V$

② ~~$V_{R_S} = V_{C_1} - V_{Z_1}$~~

=

③ $I_T = I_{Z_1} + I_{R_L}$

$= 40m + 800m$

$= 840\,mA$

④ $V_{r(p-p)} = \frac{I}{CF}$

$= \frac{840\,m}{4700\mu \times 100}$

$= 1,787\,V$

⑤ $V_{AB_p} = \sqrt{2}\,V_{rms}$

$= \sqrt{2} \times 15$

$= 21,213\,V$

⑥ $V_{C_{1_p}} = V_{AB_p} - 2Vd$

$= 21,213 - 1,4$

$= 19,813\,V$

⑦ $V_{C_{1_{AVE}}} = V_{C_{1_p}} - \frac{V_{r(p-p)}}{2}$

$= 19,813 - \frac{1,787}{2}$

$= 18,919\,V$

⑦ $V_{R_S} = V_{C_1} - V_{Z_1}$

$= 18,919 - 10$

$= 8,919\,V$

⑧ $I_{R_S} = \frac{V_{R_S}}{R_S} = \frac{8,919}{150}$

$= 59,46\,mA.$

⑨ $I_{R_S} = I_{B_{Q_1}} + V_{Z_1}$

$59,46m = I_{B_{Q_1}} + 40\,mA$

$I_{B_{Q_1}} = 19,46\,mA.$

⑩ $I_{E_{Q_1}} = I_{R_L}$

$= 800\,mA$

⑪ $I_{E_{Q_1}} = I_{C_{Q_1}} + I_{B_{Q_1}}$

$800m = I_{C_{Q_1}} + 19,46\,m$

$I_{C_{Q_1}} = 780,54\,mA.$

⑫ $P_{R_S} = V_{R_S} I_{R_S} = 8,919 \times 59,46m$

$= 530,324\,mW$

⑬ $P_{Z_1} = V_{Z_1} I_{Z_1} = 10 \times 40\,m$

$= 400\,mW$

⑭ $V_{CE_{Q_1}} = V_{C_1} - V_{R_L}$

$= 18,919 - 9,3$

$= 9,619\,V$

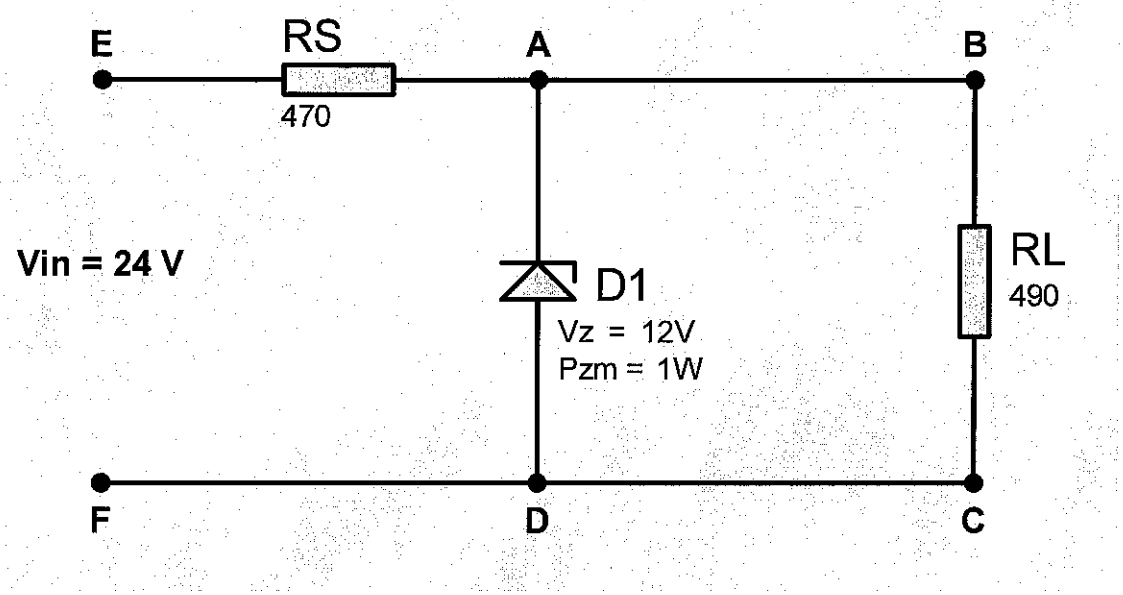
⑮ $P_{Q_1} = V_{CE_Q} I_{C_{Q_1}}$

$= 9,619 \times 780,54\,m$

$= 7,508\,W$

⑯ $I_{2_{NO\,LOAD}} = I_{R_S} = 59,46mA$

QUESTION 4 (9)



Fill in the table below

	Answer
Voltage across RS	12 V
Current through RS	25,532 mA
Voltage across D1	12V
Current through D1	1,042 mA
Voltage across RL	12V
Current through RL	24,49 mA
Power dissipated in RS	306,384 mW
Power dissipated in RL	293,88 mW
Power dissipated in D1	12,504 mW

QUESTION 4.

Vin.

① $V_{in} = V_{RS} + V_Z$

$24 = V_{RS} + 12$

$V_{RS} = 12\,V$.

② $I_{RS} = \frac{V_{RS}}{R_S} = \frac{12}{470}$

$= 25,532\,mA$.

③ $V_{D1} = V_Z$

$= 12\,V$.

④ $I_{RS} = I_{D1} + I_{RL}$.

⑤ $V_{RL} = V_{D1}$

$= 12\,V$

⑥ $I_{RL} = \frac{V_{RL}}{R_L} = \frac{12}{490}$

$= 24,49\,mA$

⑦ $I_{RS} = I_{D1} + I_{RL}$

$25,532m = I_{D1} + 24,49m$

$I_{D1} = 1,042\,mA$

⑧ $P_{RS} = V_{RS} I_{RS}$

$= 12 \times 25,532\,m$

$= 306,384\,mW$.

⑨ $P_{RL} = V_{RL} I_{RL}$

$= 12 \times 24,49\,m$

$= 293,88\,mW$.

⑩ $P_{D1} = V_{D1} I_{D1}$

$= 12 \times 1,042\,m$

$= 12,504\,mW$.