

Electronics Exam jan 14th 2022

by Joshua Warren Ede

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2022

Electronics exam

FRIDAY 14TH JANUARY 10:00

JOSHUA WARREN EDE (2023302)

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These are twenty typed words that hopefully will allow Turnitin to accept the document. If I need any more... pineapple.

I've tried to make answers clearly visible by writing ANS: nearby with an arrow if it still appears a bit unclear. Please let me know if this causes any confusion.

For further calculations in answers I've always taken the long form of the number rather than carry through rounding errors.

①

Series

①

$$R_{P1} = R_5 + (R_3 + R_6)$$

$$R_2 = R_7 + R_4$$

$$\frac{1}{R_{P2}} = \frac{1}{R_7} + \frac{1}{R_4}$$

$$\frac{1}{R_{P2}} = \frac{1}{470} + \frac{1}{330} \quad \left| \quad \frac{330}{470} \right.$$

$$\frac{330}{155100} + \frac{470}{155100}$$

②

$$\frac{1}{R_{p2}} = \frac{800}{155100}$$

$$\frac{R_{p2}}{1} = \frac{155100}{800} = 193.875 \Omega$$

$$\frac{1}{R_{p1}} = \frac{1}{R_5} + \left(\frac{1}{R_6 + R_3} \right)$$

$$\therefore R_{p1} = R_6 + R_3 = 750 + 270 = 1020 \Omega$$

$$\frac{1}{R_{p1}} = \frac{1}{150} + \frac{1}{1020} \quad \left| \quad \frac{1020}{153000} + \frac{150}{153000} \right.$$

$$\frac{1}{R_{p1}} = \frac{1170}{153000} \quad \left| \quad \frac{R_{p1}}{1} = \frac{153000}{1170} = 130.7692308 \Omega \right.$$

$$R_1 + R_2 = 100 + 310 = 410 \Omega$$

$$R_T = R_{p1} + R_{p2} + R_1 + R_2$$

$$130.7692308 + 193.875 + 100 + 310$$

$$R_T = 734.6442308 \Omega$$

(A) Ans: 734.644 Ω (3dp)

Answer to question 1 part A) labelled as (A) ANS

③

② $I = \frac{V}{R} \quad \left| \quad \frac{15}{734.6442308}\right.$

Ans: $I = 0.020418046 \text{ A}$
 $I = 20.41804641 \text{ mA}$
 $I = 20.418 \text{ mA} \quad (3dp)$

c) Total current through R_3

$I = I_{in} \frac{R_B}{R_A + R_B}$

$I = 0.020418046 \left(\frac{150}{1020 + 150} \right)$

$0.020418046 \left(\frac{150}{1170} \right)$

$0.020418046 \times 0.128205128 = 2.617698205 \times 10^{-3} \text{ A}$

Ans: $I_{R_3} = 2.617698205 \text{ mA}$
 $= 2.618 \text{ mA} \quad (3dp)$

d) $P = V \times I$
 $P = 15 \times 0.020418046$
 $P = 0.30627069 \text{ W}$
 $P = 306.27069 \text{ mW}$
 Ans: $P = 306.271 \text{ mW} \quad (3dp)$

(4)

e) Power dissipated by R_4

$$R_4 = 330 \, \Omega$$
$$I_{out} = I_{in} \frac{R_0}{R_A + R_B}$$
$$I_{in} = 0.020418046 \, A$$
$$0.020418046 \left(\frac{470}{330 + 470} \right)$$
$$0.020418046 \times 0.5875$$
$$I_{out} = 0.011995602 \, A$$
$$P = I^2 R$$
$$I^2 = 1.438944679 \times 10^{-4} \times 330$$
$$P = 0.047485174 \, W$$

Ans: $P = 47.48517442 \, mW$ ~~Ans~~

$47.485 \, mW$ (3dp)

⑤

R_7 replaced by wire link.

New circuit wire-t:

$$R_1 + R_2 + R_{p_{21}} + R_4$$

$$100 + 310 + 130.7692308 \Omega + 330$$

$$R_T = 870.7692308 \Omega$$

$$I = \frac{V}{R} \quad \Bigg| \quad I = \frac{15}{870.7692308}$$

$$I = 0.017226148 \text{ A}$$

$$= 17.22614841 \text{ mA}$$

$$I = 17.226 \text{ mA} \quad 3dp$$

2) $\rightarrow$ estimate period:

Ans: $4 \times 100 \text{ ns} = 400 \text{ ns}$

b) frequency

$$f = \frac{1}{T} \quad \Bigg| \quad \frac{1}{0.4} \quad \frac{1}{400 \text{ ns}}$$

Ans: $f = 2.5 \text{ Hz}$

c) V_{ph-ph}

$$V = 500 \text{ mV}$$

$$ph-ph = 4$$

Ans: $V_{ph-ph} = 2V$

⑥

$$2) \text{ rms} = \frac{V_{ph}}{\sqrt{2}}$$

Ans:

$$\frac{2}{\sqrt{2}} = \frac{1.414213562 \text{ V}}{1.414 \text{ V (3dp)}}$$

$$3) \quad V_c = V_0 \left(e^{-\frac{t}{\tau}} \right)$$

$$R = 40000$$

$$C = 10 \times 10^{-6}$$

$$V_0 = 12 \text{ V}$$

$$a) \quad V_c \text{ at time } \underline{1.6 \text{ s}} \quad \tau = 0.4$$

$$V_c = 12 \left(e^{-\frac{1.6}{0.4}} \right)$$

~~Answer~~

$$V_c = 0.219787666 \text{ V} \leftarrow \text{Ans}^2$$

b) labelled graph sketch see graph paper

c) stored energy:

$$E = 0.5 C V^2$$

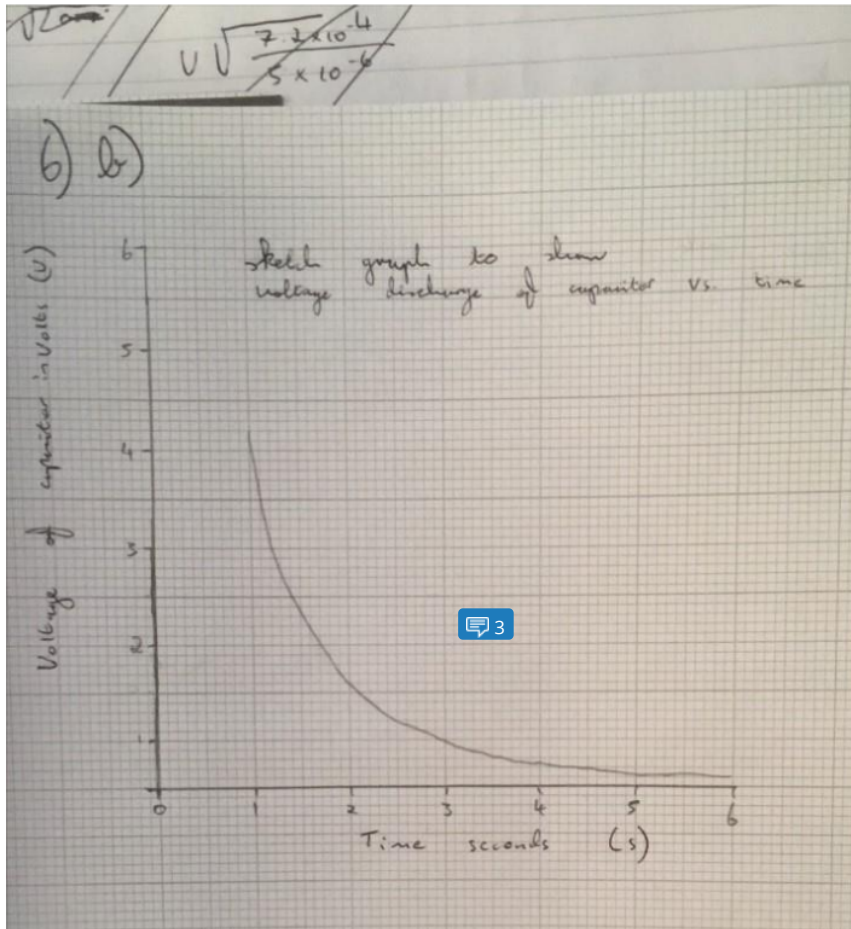
$$\text{Ans: } E = 7.2 \times 10^{-4} \text{ J}$$

$$E = 0.72 \text{ mJ}$$

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Question 3 part B) labelled sketch graph:



Graph sketch for question 3 part B) The six was meant to remind me what page in my exam script it was!

d) calculate time taken for 0.1-2

~~$$V \sqrt{\frac{E}{0.5c}}$$~~

~~$$V \sqrt{\frac{E}{5 \times 10^{-6}}}$$~~

~~$$V \sqrt{\frac{7.2 \times 10^{-4}}{5 \times 10^{-6}}}$$~~

~~$$V \sqrt{144}$$~~

~~$$V = 12$$~~

~~$$\ln \left(\frac{V_c}{V_0} \right) \times \tau = T$$~~

$$V \sqrt{\frac{E}{0.5c}} \quad \bigg| \quad V \sqrt{\frac{0.1 \times 10^{-3}}{0.5 \times 10^{-6}}}$$

$$V = \sqrt{200}$$

$$V = 14.14213562$$

$$-\ln \left(\frac{V_c}{V_0} \right) \times \tau = T$$

$$-\ln \left(\frac{14.14213562}{12} \right) \times 0.4 = T$$

Ans:

$$T = 0.065700813 \text{ seconds}$$

~~$$T = 0.0657$$~~

$$T = 65.70081329 \text{ ns} \quad 65.701 \text{ ns (3dp)}$$

⑧

4) π

a) Total impedance:

$f = 100$

$R_1 = 200 \Omega$
 $L = 200 \times 10^{-3} \text{ H}$
 $C = 5 \times 10^{-6} \text{ F}$

$X_L = 2\pi fL = 2 \times \pi \times 100 \times (200 \times 10^{-3})$
 $X_L = 125.6637061 \Omega$

$X_C = \frac{1}{2\pi fC} = \frac{1}{2 \times \pi \times 100 \times (5 \times 10^{-6})}$
 $X_C = 318.3098862 \Omega$

$X_L - X_C = -192.6461801 \Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$
 $Z = \sqrt{40000 + 37112.55071}$
 $Z = \sqrt{77112.55071}$
 $Z = 202.762301 \Omega$

Ans: 202.762301Ω
 202.762Ω (3dp)

(B)

$$I = \frac{V}{R} \quad \underline{\underline{R = 2}}$$

$$I = \frac{20}{202.762301}$$

Ans:

$$I = 0.098637665 \text{ A}$$

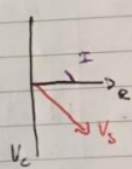
$$= 98.63766539 \text{ mA}$$
~~$$= 98.64 \text{ mA}$$~~

$$I = 98.638 \text{ mA} \quad 3dp$$

c) $\varphi = \tan^{-1} \frac{X_T}{R}$ $X_T = -192.6461801 \Omega$
 $R = 200$

Ans:

$$\varphi = -43.92704014^\circ$$

$$\varphi = -43.927^\circ \quad (3dp)$$


d) Voltage across Resistor

$$V_{out} = V_{in} \frac{R_0}{R_A + R_B}$$

$$V_{out} = 20 \left(\frac{200}{202.762301} \right)$$

Ans:

$$V_{out} = 19.72753308 \text{ V}$$

$$19.728 \text{ V} \quad (3dp)$$

10

c) Voltage across capacitor

$$V_{out} = V_{in} \left(\frac{R_B}{R_A + R_B} \right)$$

$$V_{out} = 20 \left(\frac{318.3098862}{202.762301} \right)$$

Ans: = 31.39734405 V
= 31.397 V (3dp)

f) Voltage across an inductor

$$V_{out} = 20 \left(\frac{125.6637061}{202.762301} \right)$$

Ans: = 12.39517459 V
12.395 V (3dp)

g) $f_{res} = \frac{1}{2\pi\sqrt{LC}}$ $LC = 1 \times 10^{-6}$

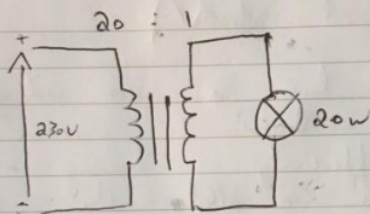
$$f_{res} = \frac{1}{6.283185307 \times 10^{-3}}$$

$$f_{res} = 159.1549431 \text{ Hz}$$

$$159.155 \text{ Hz (3dp)} \leftarrow \text{Ans}$$

5) A 230V step-down transformer has a 20W lamp
1:20

a) sketch



b) Secondary current

$$\frac{230}{20} = 11.5 \text{ V} \quad I = \frac{P}{V}$$

$$I = \frac{20}{11.5}$$

Ans: $I = 1.739130435 \text{ A}$
 1.739 A (3dp)

c) $I_p = \frac{P}{V_p}$

Ans:

$$I_p = 0.086956521 \text{ A}$$

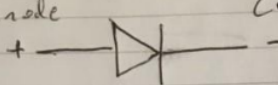
$$I_p = 86.95652174 \text{ mA}$$

$$86.957 \text{ mA (3dp)}$$

②

(c) Ans:

a) Anode Cathode



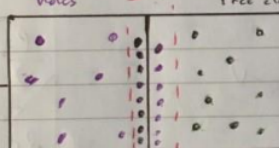
b)

~~For a forward biased diode:~~

When a diode has no voltage it provides a barrier to current. It does this by effectively leaving a 'gap' in the middle called the depletion region.

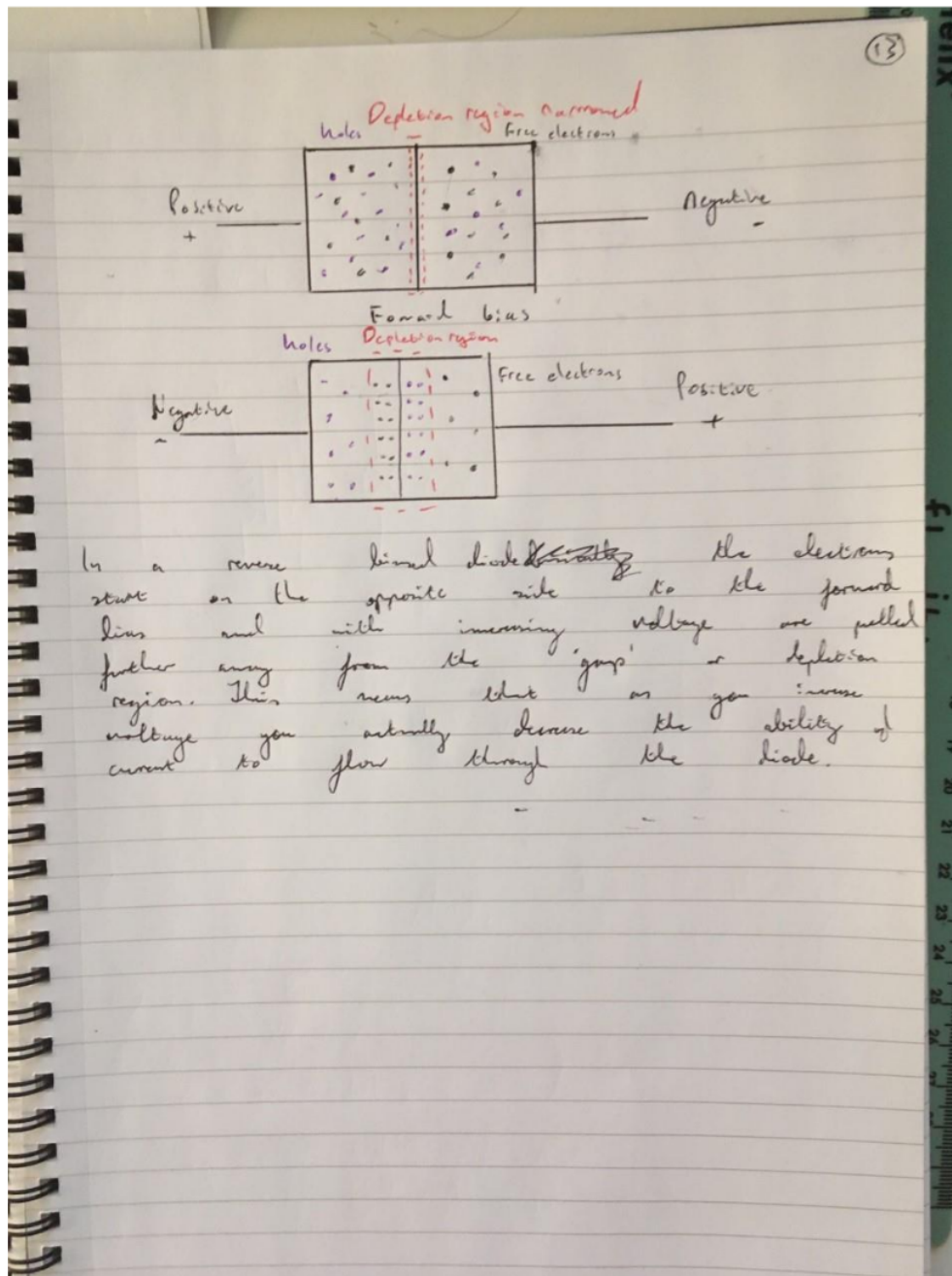
holes - - - Free electrons

Positive + Negative -



As you apply voltage a number of electrons begin to break away and become free, this creates gaps that can be filled and free electrons can fill them.

As the voltage increases further the 'fixed' electrons in the depletion region begin to break away and become free also leaving more gaps. This means the depletion region widens allowing current to flow through the diode.



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FIN

Electronics Exam jan 14th 2022

GRADEMARK REPORT

FINAL GRADE

90/100

GENERAL COMMENTS

Instructor

Total 63 out of 70 Marks

$63 / 70 \times 100 = 90\%$

Q1 - 17 Marks

a) 3 Marks

b) 2 Marks (Error Carried Forward)

c) 2 Marks ECF

d) 2 Marks ECF

e) 4 Marks ECF

f) 4 Marks ECF

Q2 - 4 Marks

a) 1 Mark

b) 1 Mark

c) 1 Mark

d) 1 Mark

Q3 - 12 Marks

a) 3 Marks

b) 3 Marks

c) 3 Marks

d) 3 Marks

Q4 - 13 Marks

a) 1 Mark

b) 2 Marks ECF

c) 2 Marks

d) 2 Marks ECF

e) 2 Marks ECF

f) 2 Marks ECF

g) 2 Marks

Q5 - 6 Marks

a) 2 Marks

b) 2 Marks

c) 2 Marks

Q6 - 11 Marks

a) 2 Marks

b) 9 Marks

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PAGE 2

PAGE 3

PAGE 4



Comment 1

The parallel combination of R4 & R7 is in series with R5.

The series / parallel combination of R4, R5 & R7 is all in parallel with R3 & R6 in series.

Then finally R1 & R2 are in series with everything else.

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Comment 2

should be Peak voltage (middle to top), not peak to peak (bottom to top) here.

PAGE 9



Comment 3

Right trend

wrong axis scales - should be 0 to 12V and 0 to 2 seconds

PAGE 10



Comment 4

$\frac{1}{2} \times C = 5\mu\text{F}$ not $0.5\mu\text{F}$

PAGE 11



Comment 5

$200^2 = 40,000$ not 4,000

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