



Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Examination Answer Books

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible answers or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

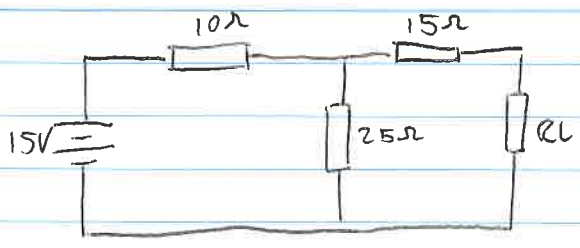
1	Student Number	2219188
2	Title of Examination Paper	Electrical ENGINEERING
3	Module Code	ACDA5001
4	Date and Time of Examination	10/5/2023 9:00am
5	Examination Venue	UWTSD IQ 310
6	Seat Number	29
7	Number of Answer Books handed in	1

[illegible]

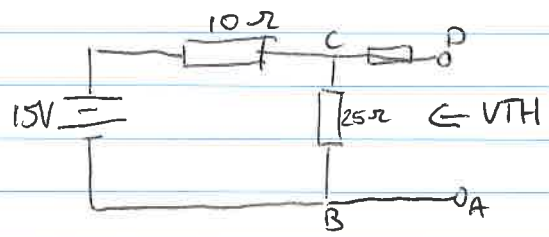
(Gweler yr ochr arall am y fersiwn Cymraeg)

85/100
EIGHT FIVE

1 a)



Remove R_L and determine V_{TH} .



$$V_{TH} = V_{AB} + V_{BC} + V_{CD}$$
$$V_{TH} = 0 + V_{BC} + V_{CD}$$
$$V_{TH} = V_{BC}$$

Resistors in series 10Ω and 25Ω

$$10\Omega + 25\Omega = 35\Omega$$

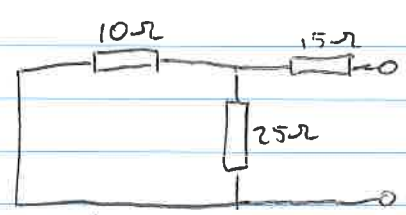
$\therefore$

$$I = \frac{V}{R}$$
$$= \frac{15}{35}$$
$$= 428.571 \text{ mA}$$

$\therefore$

$$V_{BC} = IR$$
$$= 428.571 \times 10^{-3} \times 25\Omega$$
$$V_{TH} = 10.714 \text{ V}$$

R_{TH}



10Ω and 25Ω are in parallel.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R \text{ in parallel} = \frac{1}{\frac{1}{10} + \frac{1}{25}}$$

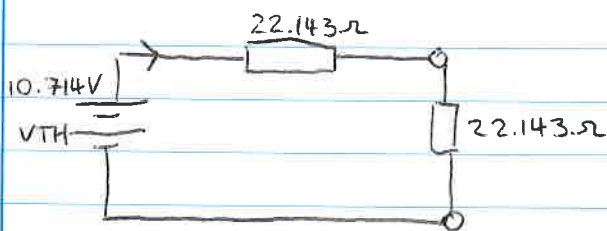
$$= 7.143 \Omega$$

In series with 15Ω

$$R_{TH} = 7.143 + 15 \Omega$$

$$= 22.143 \Omega$$

$$R_{TH} = R_L$$



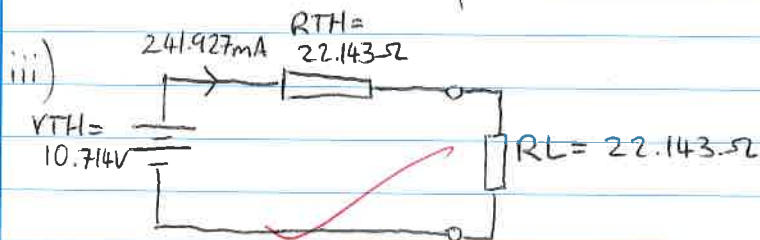
$$i) I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

$$= \frac{10.714}{22.143 + 22.143}$$

$$= 0.2419 \text{ A}$$

$$= 241.927 \text{ mA}$$

ii) Maximum power theorem states that max power transfer is achieved when R_L is equal to R_{TH} . The value of R_L is therefore 22.143Ω



$$\begin{aligned}
 \text{iv) } P_L &= I_L^2 R_L \\
 &= (241.927 \times 10^{-3})^2 \times 22.143 \\
 &= 1.296 \text{ W}
 \end{aligned}$$

3
1+2+2+2+2+3+3

- b Norton's theorem states that any two terminals, of a network consisting of passive and active elements, can be replaced by an equivalent current source and parallel resistor. The magnitude of the current source is equivalent to the short circuit current (I_{sc}) and the resistor in parallel is the equivalent resistor (R_{TH}). See the equivalent circuit below.

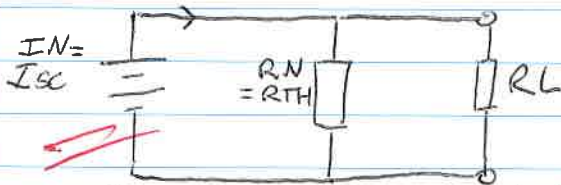
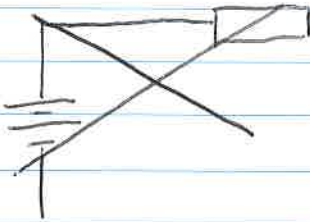
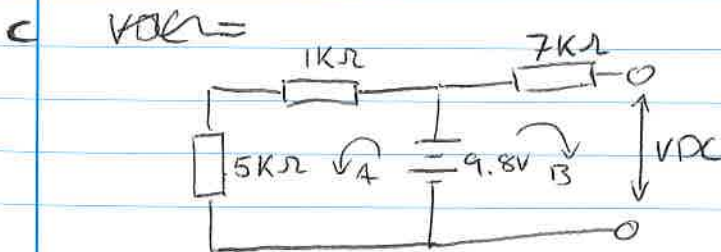


figure A. - Norton's equivalent circuit.



V_{OC} As the circuit is open, there is no voltage flowing.

6
91
1+2+2+2+3+3+2=17

2

a)

$$L = 0.1 \text{ H} \quad R = 5 \Omega \quad V = 230 \text{ V}$$

~~at $t = 0$~~ $\tau = L/R = 0.02$

Steady state current $I_0 = V/R$

$$= 230/5$$

$$= 46 \text{ A}$$

at $t = 0$

$$i = I_0(1 - e^{-Rt/L})$$

$$i = 46(1 - e^{-5 \times 0 / 0.1})$$

$$i = 46(1 - e^0)$$

$$i = 0$$

at $t = 2\tau$

$$= 2 \times 0.02$$

$$= 0.04$$

$$i = I_0(1 - e^{-5 \times 0.04 / 0.1})$$

$$= I_0(1 - e^{-0.2})$$

$$i = 46(1 - e^{-2})$$

$$i = 39.775 \text{ A}$$

2b $C = 1 \mu F$ $R = 5.45 M\Omega$ $V = 220V$

60% of supply = 132V $\tau = RC = 5.45$

$$V_C = V(1 - e^{-t/\tau})$$

$$132 = 220(1 - e^{-t/5.45})$$

$$\frac{132}{220} = 1 - e^{-t/5.45}$$

$$0.6 - 1 = -e^{-t/5.45}$$

$$0.4 = e^{-t/5.45}$$

$$\log 0.4 = -\frac{t}{5.45}$$

$$5.45 \log 0.4 = -t$$

$$-2.1688 = -t$$

$$t = 2.169 \text{ s}$$

2.169 seconds for the capacitor to charge to 60% of supply voltage.

c) $V = 100 \sin \omega t$ $R = 10 \Omega$

$$V_m = 100V$$

$$V_{RMS} = \frac{100}{\sqrt{2}}$$

$$= 70.71V$$

$$I = V/R$$

$$= 70.71/10$$

$$= 7.071A$$

$$P = VI$$

$$= 70.71 \times 7.071$$

$$= 499.99W$$

$$P = VI \cos \phi$$

Q2
2+1+1+2+2+1+2+1+5
12

$$3a \quad L = 318.3 \text{ mH} \quad R = 200 \Omega \quad V = 240 \text{ V} \quad f = 50 \text{ Hz}$$

$$\begin{aligned} \text{i) } X_L &= 2\pi fL \\ &= 2\pi \times 50 \times 318.3 \times 10^{-3} \\ &= 99.997 \Omega \end{aligned}$$

$$\begin{aligned} \text{ii) } Z &= \sqrt{R^2 + X_L^2} \\ &= \sqrt{200^2 + 99.997^2} \\ &= 223.605 \Omega \end{aligned}$$

$$\begin{aligned} \text{iii) } I &= V/Z \\ &= 240/223.605 \\ &= 1.073 \text{ A} \end{aligned}$$

$$\begin{aligned} \text{iv) } V_L &= I \times X_L \\ &= 1.073 \times 99.997 \\ &= 107.329 \text{ V} \end{aligned}$$

$$\begin{aligned} V_R &= I \times R \\ &= 1.073 \times 200 \\ &= 214.6 \text{ V} \end{aligned}$$

$$\begin{aligned} \text{v) Phase angle } \phi &= \tan^{-1}\left(\frac{X_L}{R}\right) \\ &= \tan^{-1}\left(\frac{99.997}{200}\right) \\ &= 26.564^\circ \text{ lagging.} \end{aligned}$$

$$\text{b) } I = 25 + j40 \text{ A}$$

convert to polar form

$$\begin{aligned} r &= \sqrt{x^2 + y^2} & r &= \sqrt{25^2 + 40^2} = 47.17 \\ \phi &= \tan^{-1}\left(\frac{y}{x}\right) & \phi &= \tan^{-1}\left(\frac{40}{25}\right) = 57.995^\circ \end{aligned}$$

$$I = 47.17 \angle 57.995^\circ$$

$$\therefore I = 47.17 \text{ A}$$

$$\text{Phase angle} = 57.995^\circ$$

- c) Active power refers to the amount of power used in a circuit where as apparent power is the amount supplied. The difference in power supplied and power used is known as reactive power. A circuit may only need a certain power to function ~~but~~ but due to losses through poor power factor, an increased power is drawn from the supply for the circuit to be able to utilise the power it requires. The loss is reactive power, the ~~it~~ used power is the active power and the amount taken from the supply is the apparent power.

$$4a \quad V = 120 \sin(314t) \quad I = 10 \sin(314t + \frac{\pi}{6})$$

$$V_m = 120, \quad V_{RMS} = \frac{V_m}{\sqrt{2}} \quad I_m = 10, \quad I_{RMS} = \frac{I_m}{\sqrt{2}}$$

$$= 84.853 \text{ V} \quad = 7.071 \text{ A}$$

$$\omega = 2\pi f = 314$$

$$\therefore f = 49.975 \text{ Hz}$$

$$\frac{\pi}{6} = \frac{180}{6} = 30^\circ$$

$$Z = V/I = 84.853/7.071$$

$$= 12.0001 \Omega$$

Convert $12.001 \angle 30$ to rectangular form.

$$X = r \cos \phi$$

$$Y = r \sin \phi$$

$$X = 12.001 \cos 30$$

$$= 10.393$$

$$Y = 12.001 \sin 30$$

$$= 6.0005$$

Compare with $z = R - jX_C$

$$= 10.393 - j6.0005$$

$$\therefore R = 10.393 \Omega$$

P.F.D

(continued 4a)

$$X_C = 6.0005$$

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

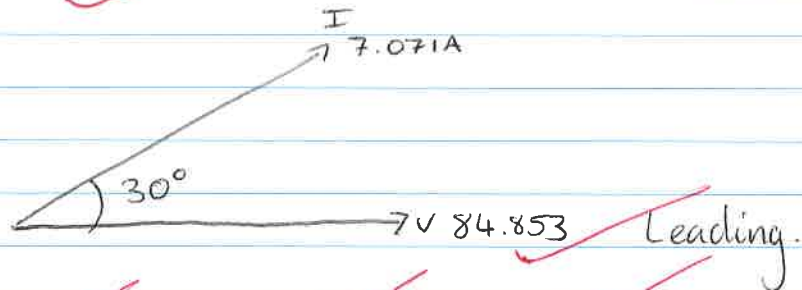
$$\therefore C = \frac{1}{2\pi f X_C}$$

$$= \frac{1}{2\pi \times 49.975 \times 6.0005}$$

$$C = 530.738 \mu F$$

$$\begin{aligned} \text{Power} &= VI \cos \phi \\ &= 84.853 \times 7.071 \times \cos 30 \\ &= \cancel{1039.230} \text{ W} \\ &= 519.611 \text{ W} \end{aligned}$$

iii)



b) $L = 0.20 \text{ H}$ $R = 60 \Omega$ $C = 20 \mu F$ $V = 20 \text{ V}$

$$\begin{aligned} \text{i) } f_r &= \frac{1}{2\pi \sqrt{LC}} \\ &= \frac{1}{2\pi \sqrt{0.20 \times 20 \times 10^{-6}}} \\ &= 79.577 \text{ Hz} \end{aligned}$$

$$\begin{aligned} \text{ii) } R_D &= \frac{L}{RC} \\ &= \frac{0.20}{60 \times 20 \times 10^{-6}} \\ &= 166.667 \Omega \end{aligned}$$

$$\begin{aligned}
 \text{iii) } I_r &= \frac{V}{R_D} \\
 &= \frac{20}{166.667} \\
 &= 0.12 \text{ A}
 \end{aligned}$$

2

✓

$$\begin{aligned}
 \text{iv) } Q &= \frac{2\pi B_s L}{R} \\
 &= \frac{2\pi \times 79.577 \times 0.20}{60} \\
 &= 1.667
 \end{aligned}$$

$$\begin{aligned}
 &Q_4 \\
 &1+1+1+3+2+2+1+2+2+1 = 16
 \end{aligned}$$

1

✓

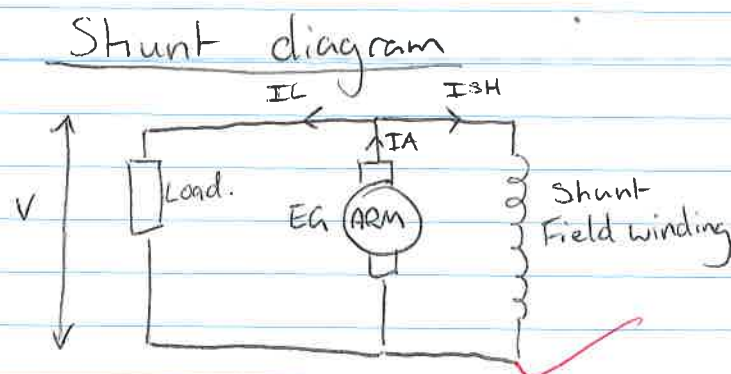
6. a) Types of DC generators:
- separately excited
 - self excited ✓
 - SHUNT ✓
 - Series ✓
 - Compound ✓
 - long shunt ✓
 - short shunt ✓
 - Differential ✓
 - Cumulative. ✓

5

✓

A shunt generator has a field winding in parallel with the armature. Its field is high resistance made up of lots of turns of thin wire. The diagram for a shunt DC generator can be found on the following page.

8



V = terminal voltage

E_G = EMF Generated

ARM = Armature

I_L = Load current

I_{sh} = Shunt field ~~in~~ current

I_A = Armature current

R_A = ARM resistance

R_{sh} = Shunt resistance.

$$I_A = I_{sh} + I_L$$

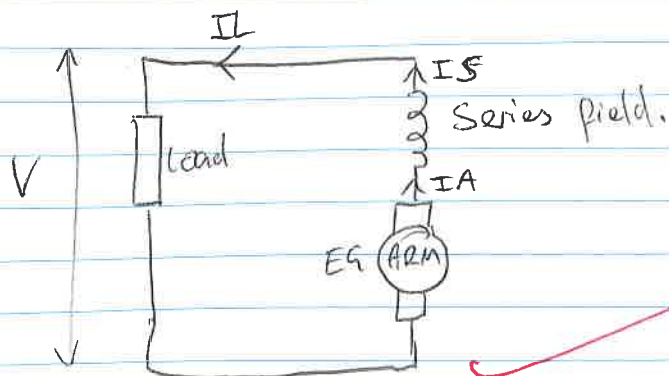
$$I_{sh} = \frac{V}{R_{sh}}$$

$$V = E_G - (I_A R_A)$$

Another type of generator is a series DC generator in this configuration the field winding is connected in series with the armature. This type of winding is low resistance, thick wire with low turns. The diagram can be seen on the following page.



Series Generator.



V = terminal voltage

I_L = Load current

ARM = Armature

E_G = EMF Generated

I_A = ARM current

R_A = ARM Resistance

R_S = Series resistance

I_S = Series current

$$I_A = I_S = I_L = I$$

$$V = E_G - I(I_A R_A)$$

$$I_S = \frac{V}{R_S}$$

6b)

ratio 8:1

$$I_1 = 3A$$

$$V_1 = 240$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

$$N_1 = 8 \quad N_2 = 1$$

$$\frac{8}{1} = \frac{240}{x} \quad x = \frac{240}{8} = 30 \quad \therefore V_2 = 30V$$

$$5+5+4+1+4=19$$