



12 Pages

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1	Student Number	2026771
2	Title of Examination Paper	Electrical Engineering
3	Module Code	ACDAS001
4	Date and Time of Examination	10/5/23 9:00
5	Examination Venue	Room 310
6	Seat Number	27
7	Number of Answer Books handed in	1

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

53/100 ~~per~~
FIVE THREE

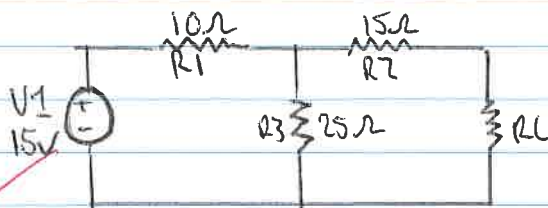
1a)

$$V_1 = 15V$$

$$R_1 = 10\Omega$$

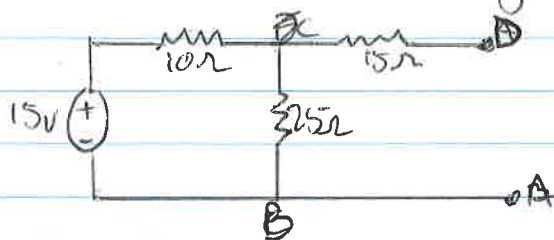
$$R_2 = 15\Omega$$

$$R_3 = 25\Omega$$

Step 1

i) Find The load current

• Remove the load causing an open circuit then calculate V_{th} .



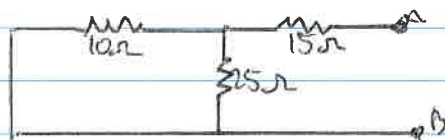
$$V_{TA} = V_{AB} + V_{BC} + V_{CD}$$

$$V_{th} = 0 + V_{BC} + 0$$

$$V_{th} = V_{BC}$$

$$\text{Using Ohms law } I = \frac{V}{R} = \frac{15}{25} = 0.6A$$

To find R_{th} remove the voltage source



The 10Ω is in parallel with 25Ω

$$\text{So } \frac{1}{R_T} = \frac{1}{10} + \frac{1}{25} = 0.14\Omega$$

$$\frac{1}{0.14} = 7.14\Omega$$

$$(R_1 + R_3) + R_2 = 7.14 + 15 = 22.14\Omega$$

$$R_{th} = 22.14\Omega$$

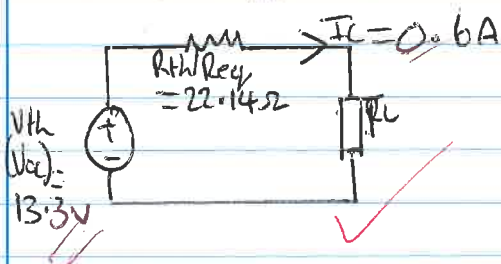
$$V_{th} = I \times R = 0.6 \times 22.14 = 13.3V$$

$$I_L = \frac{V}{R} = 0.6A$$

1a i)

(continuation)

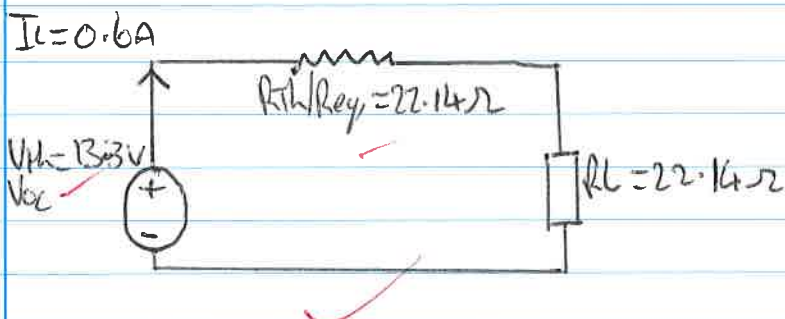
Thevenin's final circuit



1a ii)

Maximum power transfer states that maximum power will be transferred when the load resistor is equal to the internal resistance of the circuit. This means the load resistor will be 22.14Ω for maximum power transfer.

1a, iii)



1a, iv)

The maximum power transferred across the load (P_L) is:

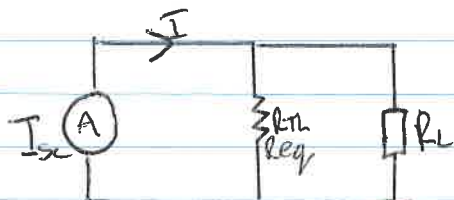
$$P_L = I^2 \times R_L$$

$$P_L = (0.6)^2 \times 22.14$$

$$= 7.9704 \text{ W}$$

1b)

Norton's theorem states that any two terminals in a network that consists of active or passive elements can be replaced by an equivalent current source and an equivalent parallel resistor. ~~The current~~

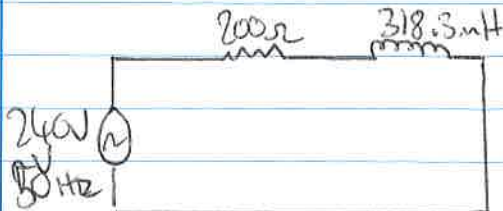


1c)

$$V_{DC} = I \times R$$

$$Q_1 \\ 1 + 2 + 2 + 1 + 1 + 2 + 1 = 10$$

Q3 a)

i) inductive reactance of coil

$$X_L = 2\pi fL$$

$$X_L = 2\pi \times 50 \times 318.3 \times 10^{-3}$$

$$X_L = 100 \Omega$$

ii) Impedance of circuit

$$Z = \sqrt{R^2 + X_L^2}$$

$$Z = \sqrt{200^2 + 100^2}$$

$$Z = 224 \Omega$$

iii) Current in circuit

$$I = \frac{V}{Z}$$

$$I = \frac{240}{224}$$

$$I = 1.07 \text{ A}$$

iv) Potential difference across each component

~~$$V = I \times R$$~~

~~$$V =$$~~

~~$$V_1$$~~

~~$$V_R = I \times R$$~~

~~$$V_R = 0.6 \times 200$$~~

~~$$V_R = 120 \text{ V}$$~~

~~$$V_L = I \times R$$~~

~~$$V_L = 0.6 \times 100$$~~

~~$$V_L = 60 \text{ V}$$~~

Q3 iiv) Potential difference across each component.

$$V_1 = V \times \frac{R_2}{R_1 + R_2} = 240 \times \frac{100}{200 + 100} = 80 \text{ V}$$

$$V_1 = 80 \text{ V} \quad V_2 = 240 - 80$$

$$V_2 = 160 \text{ V}$$

v) Phase angle

$$\phi = \tan^{-1} \left(\frac{X_L}{R} \right)$$

$$\phi = \tan^{-1} \left(\frac{100}{200} \right)$$

$$\phi = 26.6^\circ$$

Q3 b) Find RMS value and phase current of $I = 25 + j40 \text{ A}$

c) Differentiate Active, reactive and Apparent power.

Active power (P) is the power that is used for the application i.e. turning a fan. $P = VI \cos \phi$

Reactive power (Q) is the power that is wasted and not used as intended for the application i.e. heat. $Q = VI \sin \phi$

Apparent power (S) is the overall power supplied (Active + reactive power)

$$S = VI$$

Q3
 $2 + 2 + 2 + 2 + 4 = 12$

Q4 a)

$$V = 120 \sin(314t)$$

$$I = 10 \sin(314t + \frac{\pi}{6})$$

i) Value of resistance or capacitance.

Known:

$$V_m = 120$$

$$V_{rms} = \frac{120}{\sqrt{2}}$$

$$V_{rms} = 84.9 \text{ V}_{rms}$$

$$I_m = 10$$

$$I_{rms} = \frac{10}{\sqrt{2}}$$

$$I_{rms} = 7.07 \text{ A}$$

$$R = \frac{V}{I} = \frac{84.9}{7.07} = 12 \Omega$$

$$X_C = \frac{1}{\omega C}$$

$$\omega = 2\pi f$$

$$2\pi f = \omega$$

$$f = \frac{\omega}{2\pi}$$

$$f = \frac{314}{2\pi}$$

$$f = 50 \text{ Hz}$$

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

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

$$t = \frac{1}{50}$$

$$t = 0.02$$

$$\text{Phase angle} = \frac{t}{T} \times 360$$

$$\phi = \frac{50}{360}$$

$$\text{Phase angle} = \frac{\pi}{6}$$

$$\phi = \frac{180}{6}$$

$$= 30^\circ$$

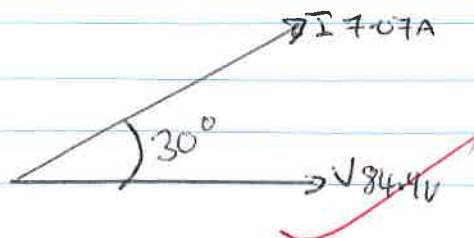
ii) Power Consumed by Circuit

$$S = VI$$

$$S = 84.9 \times 7.07$$

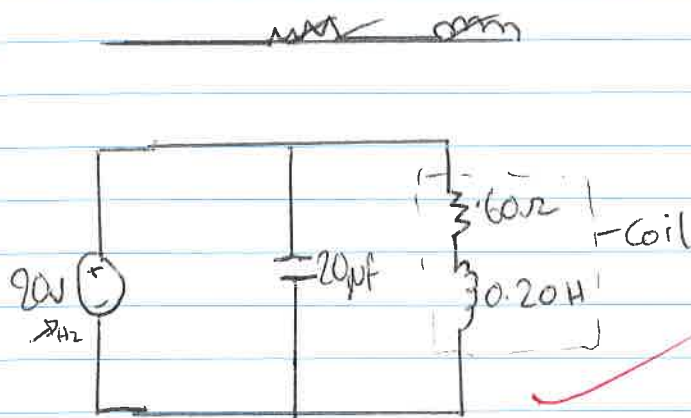
$$= 600.2 \text{ VA}$$

iii)

Phasor diagram

Current leading voltage
as it is a capacitive
circuit.

B.)

i) resonance frequency

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{0.20 \times (20 \times 10^{-6})} - \frac{60^2}{0.20^2}}$$

$$f_r = 63.66 \text{ Hz}$$

ii) Dynamic resistance

$$R_D = \frac{V}{I_r} = \frac{1}{R_C}$$

$$R_D = \frac{60}{60 \times (20 \times 10^{-6})}$$

$$R_D = 166.6 \Omega$$

iii) Current @ resonance

$$I_r = \frac{V_{RC}}{L}$$

$$I_r = \frac{20 \times 60 \times 20 \times 10^{-6}}{0.20}$$

$$I_r = 0.12 \text{ A}$$

B iv) Q-factor @ resonance

$$Q = \frac{2\pi f L}{R}$$

$$Q = \frac{2 \times \pi \times 63.66 \times 0.20}{60}$$

$$Q = 1.33$$

Q4
2+1+1+2+1+3+2+2+2=16

5a) 400V 3phase Star Supplies delta
LOAD

$$i) Z_p = \sqrt{R^2 + X_L^2}$$

$$Z_p = \sqrt{30^2 + 40^2}$$

$$Z_p = 50 \Omega$$

$$~~V_L = \sqrt{3} V_p~~ \quad V_L = \sqrt{3} V_p$$

$$~~V_L = \sqrt{3} 400~~ \quad V_L = \sqrt{3} \times 400$$

$$~~V_p = \frac{V_L}{\sqrt{3}}~~$$

$$V_p = \frac{V_L}{\sqrt{3}}$$

$$V_p = 230.9V$$

$$I_p = \frac{V_p}{Z} = \frac{230.9}{50} = 4.618A$$

$$I_L = \sqrt{3} I_p$$

$$I_L = \sqrt{3} \times 4.618 = 7.98A$$

$$I_L = 8A$$

ii) Output power of the alternator

$$\text{Active } P = VI \cos \phi$$

$$P = \sqrt{3} V_L I_L \cos \phi$$

$$\phi = \tan^{-1} \left(\frac{X_L}{R} \right) = \tan^{-1} \left(\frac{40}{30} \right) = 53.13^\circ$$

$$P = \sqrt{3} \times 400 \times 230.4 \times \cos(53.13)$$

$$P = 95984$$

$$P = 95.984$$

iii) kVA of alternator

$$S = \sqrt{3} \times V_L \times I_L$$

$$S = \sqrt{3} \times 400 \times 8$$

$$S = 5543 \text{ VA}$$

$$S = 5.5 \text{ kVA}$$

b)

$$Q5 \\ 2+1+1=4$$

2

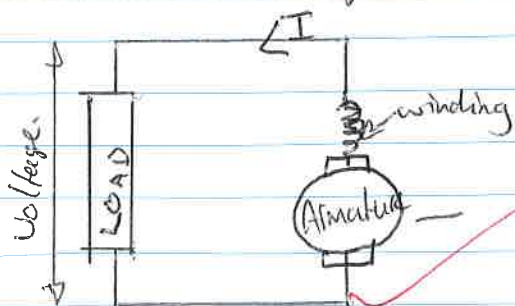
Q6 a) Types of DC Generators

- Self excited DC generator (field windings supplied by itself) ✓
- Excited DC generator (field windings supplied by external source)
- Shunt Wound Generator ✓
- Series Wound generator ✓
- Compound generators: ✓
- long shunt wound generator ✓
- Short shunt wound generator ✓
- Differential wound generator ✓

Series wound Generator

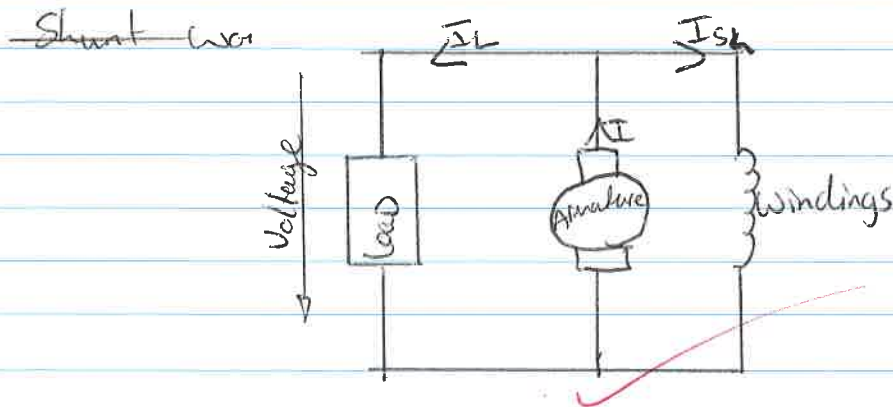
A Series wound generator is when the windings are in series with the armature. This results in the windings having the same current going passing through as the load will. As the windings will be taking full load the windings are made with a thick wire and small resistance.

Series wound diagram



Shunt wound generator

A shunt wound generator is built so the windings are in parallel with the Armature. This results in split current between the windings and the load. To achieve maximum current at the load the windings are normally made with high resistance to the ensure maximum power to the load.



6 B)

Tx has 8:1 ratio

Primary is 3A @ 240V

Find Secondary Voltage.

$$\frac{240}{9} = 26.6V \quad 26.6 \times 8 = 212.8 \quad 240 - 212.8 = 27.2$$

$$8 \times 240 - 26.6 =$$

Secondary Voltage = 27.2V

$$26 \\ 5 + 3 + 3 = 11$$