

**T490(E)(N13)T
NOVEMBER EXAMINATION
NATIONAL CERTIFICATE
ELECTRICAL TRADE THEORY N3**

(11041263)

**13 November 2014 (Y-Paper)
13:00–16:00**

This question paper consists of 9 pages and 1 formula sheet.

1. Answer ALL the questions.
 2. Read ALL the questions carefully.
 3. Number the answers correctly according to the numbering system used in this question paper.
 4. Where applicable, answers MUST be in accordance with the SABS (SANS) Code of Practice SANS 10142-1:2003 for the Wiring of Premises.
 5. Sketches MUST be neatly labelled and large enough to show the required detail.
 6. Answers MUST be given to TWO decimal places.
 7. Write neatly and legibly.
-

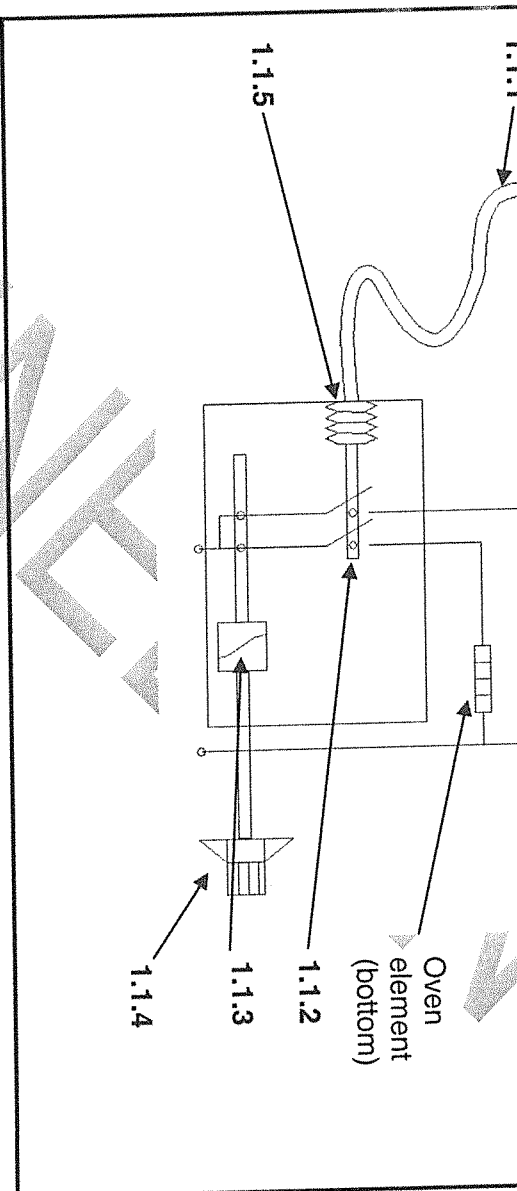


FIGURE 1

- 1.2 Explain the operation of the oven thermostat as shown in QUESTION 1.1.

(5)
[10]

QUESTION 2: PROTECTION

- 2.1 State whether the following household appliances/components need 'to BE earthed' or 'NOT earthed':

2.1.1 Metal light fittings for fluorescent tubes that are 2,4 m or above the floor.

2.1.2 The metal taps that are connected by PVC water pipes to the water supply.

2.1.3 Metal conduits used for house wiring. (3 × 1) (3)

2.2 Name TWO methods of checking if the earth-leakage relay is operating correctly. (2)

2.3 State the approximate value of the fault current that should activate the earth leakage. (1)

- 3.1 State TWO advantages of sodium-vapour discharge lamps. (2)
- 3.2 State ONE disadvantage of sodium-vapour discharge lamps. (1)
- 3.3 Explain how the glow starter in a fluorescent lamp circuit starts the lamp. (2)
- 3.4 Study the circuit below in **FIGURE 2.1**. Label the parts numbered (a) – (e) in your answer script.

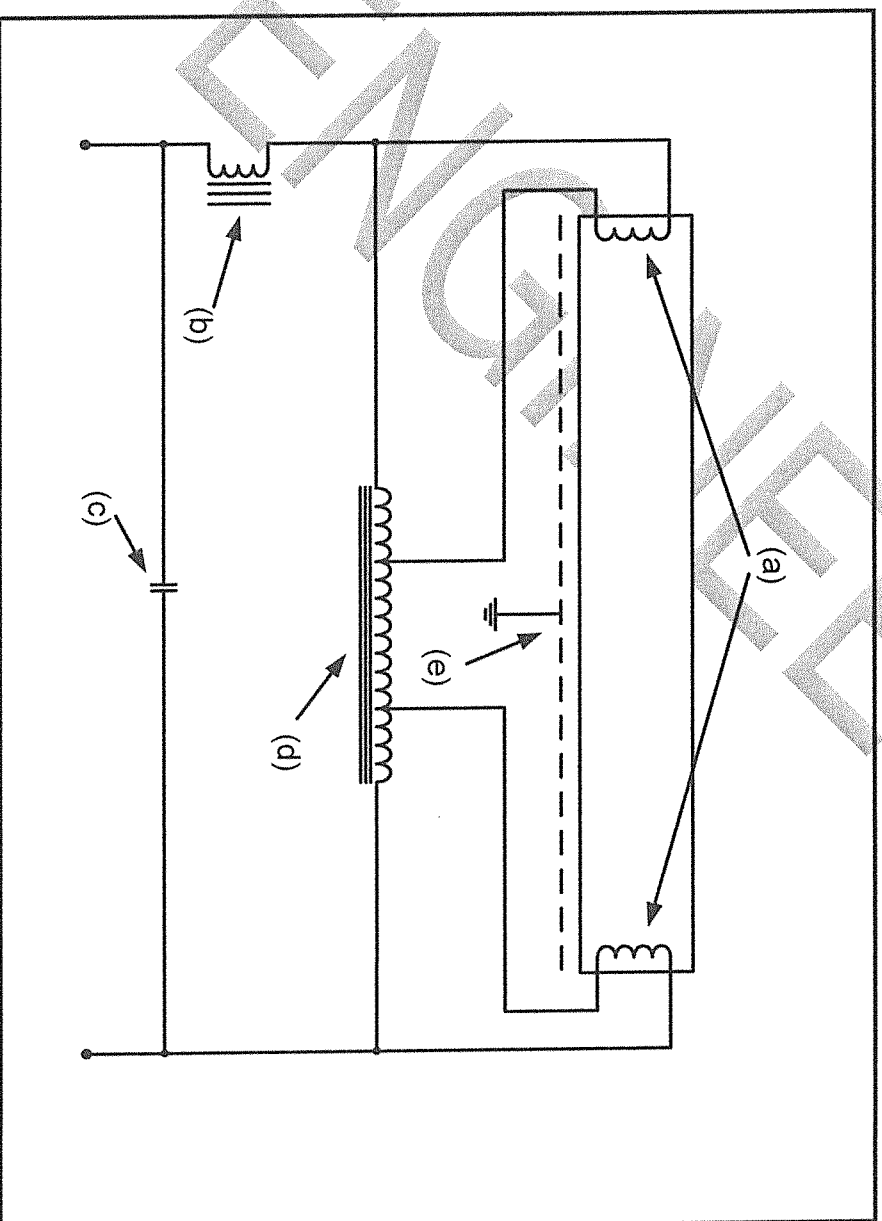


FIGURE 2.1: LIGHT FITTING

(5)
[10]

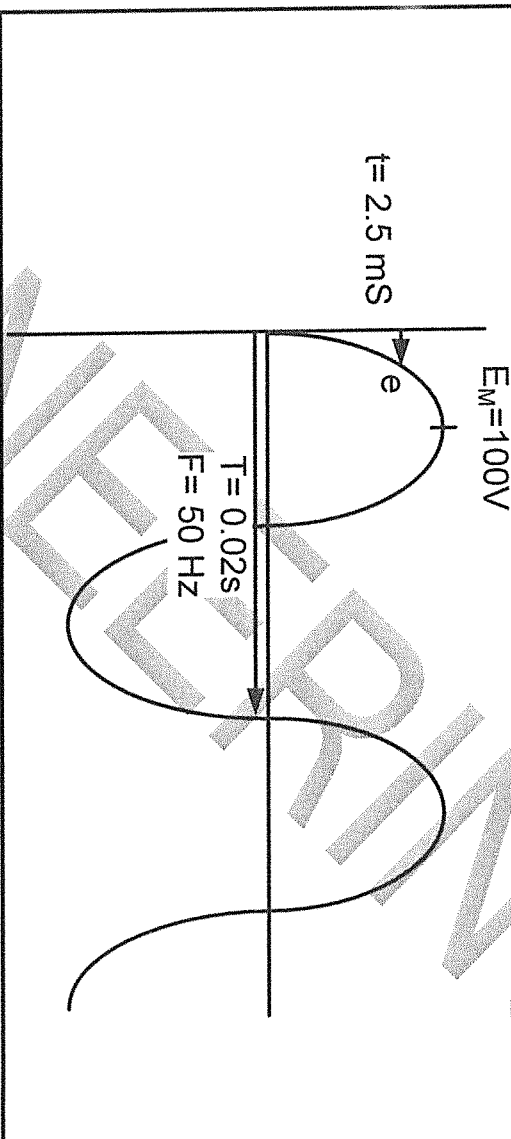


FIGURE 4.1: SINE WAVE

4.3 Calculate the RMS value of a sine wave with the following equation:

$$e = 285 \sin 2\pi f t$$

(3)

[10]

QUESTION 5: SERIES RLC CIRCUITS

5.1 Study the circuit in FIGURE 5.1 and answer the following questions.

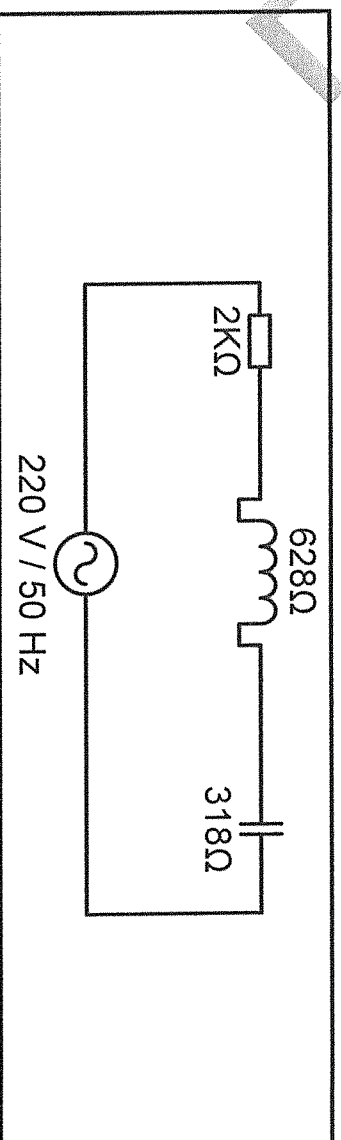


FIGURE 5.1: SERIES RLC CIRCUIT

5.1.1 Calculate the impedance of the circuit (3)

5.1.2 Calculate the total current in the circuit (3)

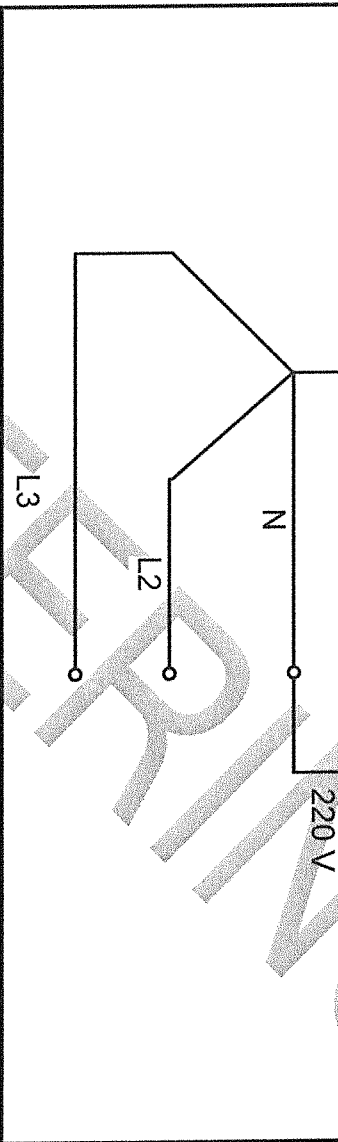


FIGURE 6.1: 3-PHASE AC SYSTEM

(3)

6.2 A 3-phase motor rated at 25kW draws a full-load current of 42,2 A from a 380 V supply at a power factor of 0,8. Calculate the:

6.2.1 Output Power of the motor

(3)

6.2.2 Efficiency of the motor.

(3)

6.2.3 State ONE type of loss that would explain why the output of a motor is lower than the power supplied to it

(1)

[10]

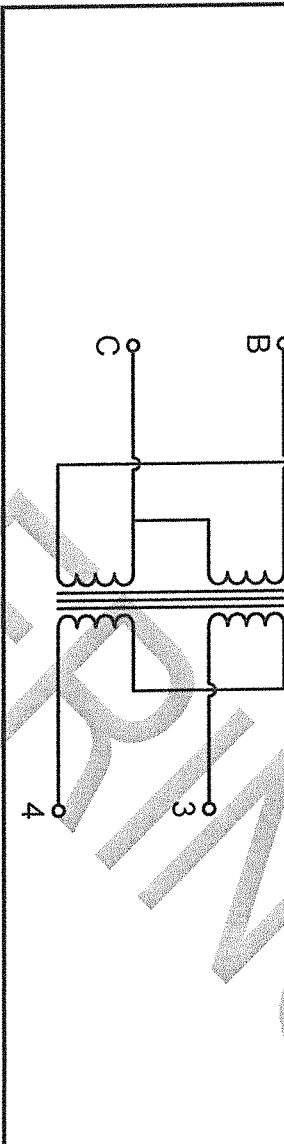


FIGURE 7.1: THREE PHASE TRANSFORMER

- 7.1 Identify the configuration of the PRIMARY windings (1)
- 7.2 Identify the configuration of the secondary windings (1)
- 7.3 Determine the voltage between A1 and A2 (1)
- 7.4 Calculate the output voltage at between 2 and 3 if the transformer has a turns ratio of 1 : 10. (3)
- 7.5 Calculate the total power consumed. (3)
- 7.6 Identify the Neutral point on the secondary winding of the transformer (1)
[10]

QUESTION 8: DC MACHINES

- 8.1 With reference to DC motors, explain the term "armature reaction" (2)
- 8.2 8.2.1 Draw a graph of the load characteristics of a cumulatively compounded DC motor as compared to a shunt motor to show how speed changes as the load increases. Label all aspects of the graph. (4)
- 8.2.2 With reference to its torque characteristics, explain what happens to a series motor if the speed increases. (1)
- 8.3 Briefly explain, during starting, how you would couple a very large DC motor so that it is NOT damaged by overcurrent. (3)
[10]

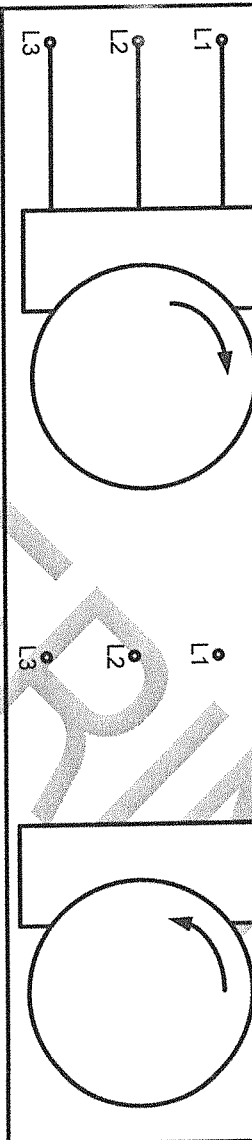


FIGURE 9.1: DIRECTION OF ROTATION

(2)
[10]

QUESTION 10: MEASURING INSTRUMENTS AND ELECTRONICS

10.1 Study the circuit in FIGURE 10.1 and answer the following questions.

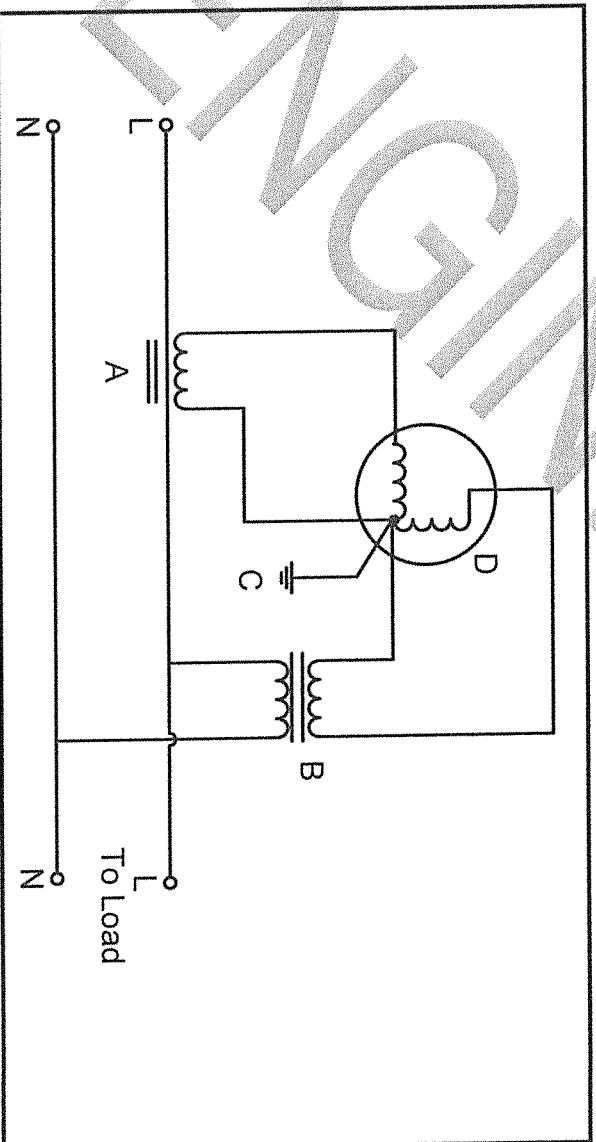


FIGURE 10.1: POWER MEASUREMENT

10.1.1 Identify the Parts A, B, C and D (4)

10.1.2 State the purpose of parts A and B (1)

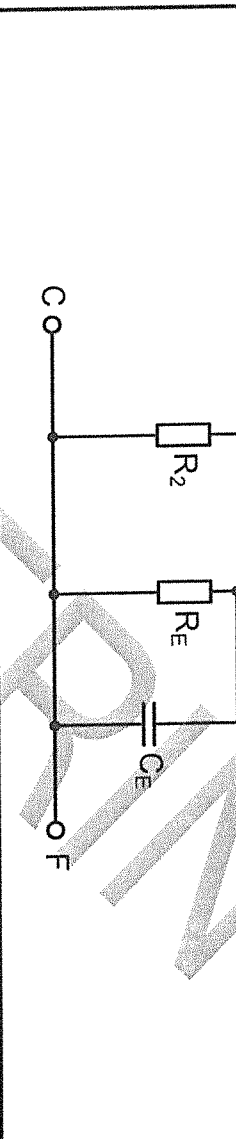


FIGURE 10.2: AMPLIFIER

- 10.2.1 Identify the type of transistor being used
- 10.2.2 State in which configuration is the transistor coupled
- 10.2.3 Identify the point where the input signal should be connected
- 10.2.4 Identify the point where the amplified signal appears
- 10.2.5 In order for this circuit to operate it needs a D.C-source. Identify the point where the negative of the battery should be coupled.
(5 × 1)

TOTAL: 100

$$\phi = \cos^{-1} \left(\frac{R}{Z} \right)$$

$$V_R = I_T R$$

$$V_{XL} = I_T X_L$$

$$V_{XC} = I_T X_C$$

$$V = \sqrt{V_R^2 + (V_{XL} - V_{XC})^2}$$

$$P = I^2 R$$

$$S = VI$$

3-phase

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

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

DELTA

$$V_L = V_{PH/F}$$

$$I_L = \sqrt{3} I_{PH/F}$$

STAR

$$V_L = \sqrt{3} V_{PH/F}$$

$$I_L = I_{PH/F}$$

$$i = I_m \sin(\omega t)$$

$$I_{rms} = 0.707 I_m$$

$$I_{ave} = 0.637 I_m$$

$$I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + \dots + i_n^2}{n}}$$

$$I_{ave} = \frac{i_1 + i_2 + \dots + i_n}{n}$$

$$\text{Form factor} = \frac{\text{RMS value}}{\text{AVE value}}$$

$$\text{Crest factor} = \frac{\text{MAX value}}{\text{RMS value}}$$

SERIES

$$R_T = R_1 + R_2 + \dots + R_n$$

PARALLEL

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

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

ELECTRICAL TRADE THEORY N3

13 NOVEMBER 2014

This marking guideline consists of 8 pages.

1.1.2 Micro-switch ✓

1.1.3 Temperature adjusting cam ✓

1.1.4 Control (adjust) knob ✓

1.1.5 Expansion bellows ✓

(5)

1.2

- When oven cold, bellows contracted and micro-switches closed. ✓
- Current flows in upper and lower heating element. ✓
- Gas in tube expands with temperature.
- Cam adjusts contacts so that a larger movement is required to open them. ✓
- When desired temperature reached, both contacts opened by bellow movement. ✓
- As oven cools, the bottom element's switch closes and keeps oven at temperature. ✓

(Any 5 × 1)

(5)
[10]

QUESTION 2: PROTECTION

2.1

2.1.1 Need to be earthed. ✓

2.1.2 Need not be earthed. ✓

2.1.3 Need to be earthed. ✓

(3 × 1)

(3)

2.2

- Use the test button on the relay. ✓
- Connect a tester at an outlet between earth and live that draws no more than 20 mA. ✓

(2)

2.3

Above 15 to 20 mA. ✓

(1)

3.1

- Efficiency is high. ✓
- Does not need to be cool before restarting. ✓

(2)

3.2

Light is yellow. ✓

(1)

3.3

The glow starter heats up and thus opens. ✓ This causes the field around the choke to collapse and a voltage surge occurs across the tube. ✓

(2)

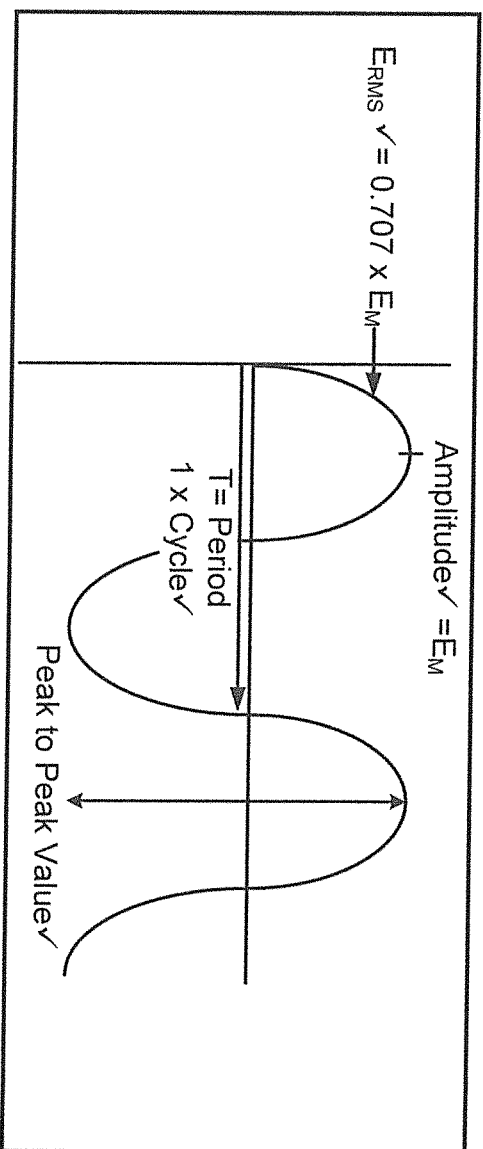
3.4

- (a) Filaments ✓
- (b) Choke ✓
- (c) Capacitor ✓
- (d) Autotransformer
- (e) Earthed Enclosure ✓

(5)
[10]

QUESTION 4: ALTERNATING CURRENT THEORY

4.1



(4)

4.2

$$e = 100 \sin(2\pi ft)$$

$$e = 100 \sin(314.159 \times 0.0025)$$

$$e = 100 \sin(0.785 \text{ rad})$$

$$e = 100 \times 0.706$$

$$e = 70.6 \text{ Volt}$$

(3)

ω

$$I = \frac{220}{1032.8}$$

$$I = 0.108 \text{ A}$$

$$\omega$$

$$\omega$$


$$\eta = \frac{22\,200}{25\,000} \times 100\% \checkmark$$

$$\eta = 0.88 \times 100\%$$

$$\eta = 88\% \text{ efficient} \checkmark$$

(3)

6.2.3 Mechanical Losses ✓

Phase Angle

Copper and Iron Losses

I^2R Losses

(1)

[10]

QUESTION 7: TRANSFORMERS

7.1 Delta ✓

(1)

7.2 Star ✓

(1)

7.3 $V_P \text{ phase} = V_{P_L}$
= 380 V ✓

(1)

7.4

$$\text{Turns ratio: } \frac{N_1}{N_2} = \frac{V_1}{V_2} \checkmark$$

$$\text{Turns ratio: } \frac{1}{10} = \frac{380}{V_2} \checkmark$$

$$\text{Turns ratio: } V_2 = 380 \times 10$$

$$\text{Turns ratio: } V_2 = 3800 \text{ Volt} \checkmark$$

(3)

7.5

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

$$P = \sqrt{3} \times 380 \times 2000 \times 0.8 \checkmark$$

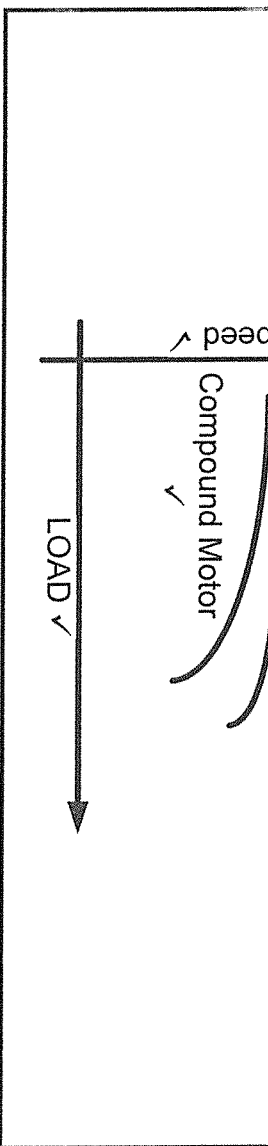
$$P = 1053 \text{ Watt} \checkmark$$

(3)

7.6 4 = Neutral ✓

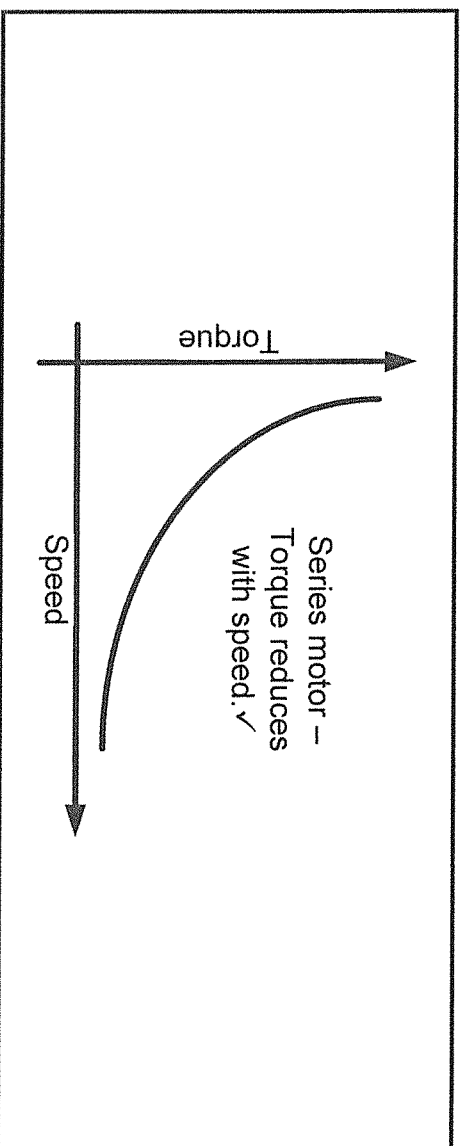
(1)

[10]



(4)

8.2.2



(1)

8.3

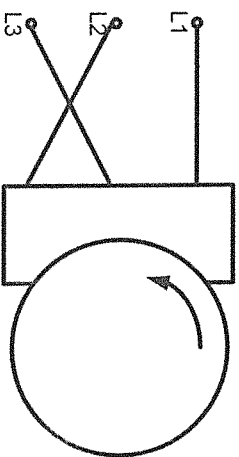
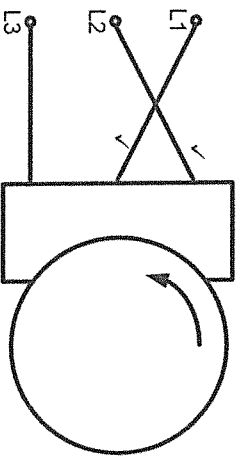
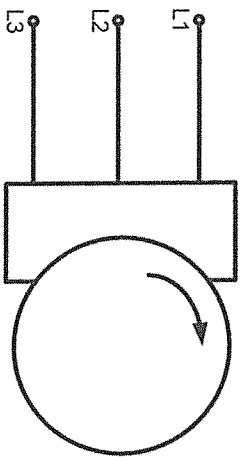
Insert a resistor bank in series with the armature and gradually reduce this resistor value as the back EMF increases. ✓

(3)
[10]

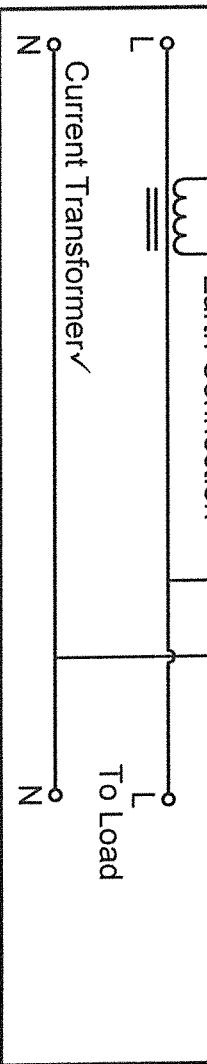


(5)

9.3



(2)
[10]



(4)

10.1.2 Instrument transformers reduce the voltage to a safe value for measurement.

(1)

10.2 10.2.1 NPN. ✓

10.2.2 Common emitter. ✓

10.2.3 Between B and C. ✓

10.2.4 Between E and F. ✓

10.2.5 On the CF line or at C or at F. ✓

(5 × 1)

(5)
[10]

TOTAL: 100