higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T460**(E)**(A5)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

ELECTRICAL TRADE THEORY N3

(11041263)

5 April 2016 (X-Paper)
09:00–12:00

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

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTRICAL TRADE THEORY N3
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers 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 neat, labelled and large enough to show the required detail.
6. Answers must be given to TWO decimal places.
7. Write neatly and legibly.

QUESTION 1: DOMESTIC APPLIANCES

1.1 A stove using 40 A must be installed in a new house.

Explain the procedure of installing a stove, type of materials used and placement of parts. Start from the distribution board to the stove's screw connectors. (4)

1.2 Explain how you would test each circuit (plate number 1 and oven) of the above stove for continuity with the aid of an ohm-meter. (3)

1.3 Draw the single phase sub-circuit that adheres to wiring code regulations that would supply the stove with power. (3)

[10]

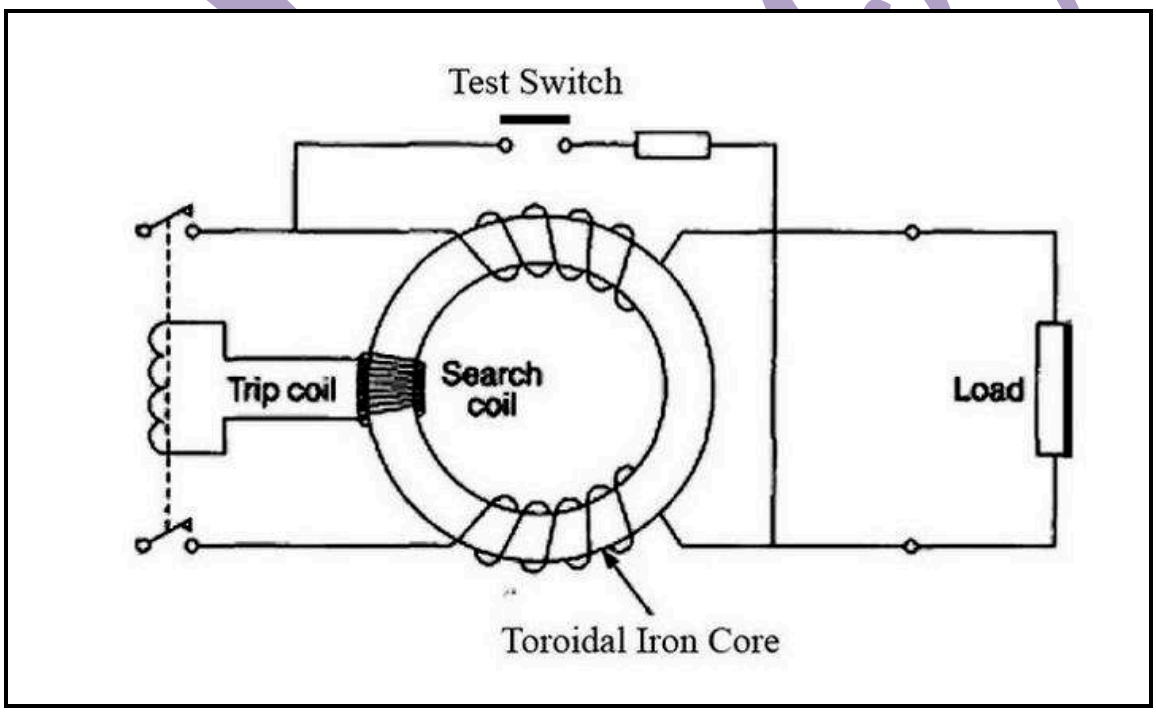
QUESTION 2: PROTECTION

2.1 Name the conductors in a single-phase domestic installation that the earth-leakage relay disconnect when the earth-leakage protection is activated. (2)

2.2 State what value of 220 V AC current is it considered dangerous to humans (2)

2.3 FIGURE 2.1 shows a Balanced Core Earth Leakage Relay.

Explain the operating principle of a core balance earth-leakage relay.



(6)

FIGURE 2.1: BALANCED CORE EARTH LEAKAGE RELAY

[10]

QUESTION 3: ILLUMINATION

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

3.1.1 A fluorescent tube emits light because of a continuous electric arc in the tube.

3.1.2 Gasses used in discharge lamps have a positive temperature coefficient of resistance and the current needs to be limited as the temperature increases.

3.1.3 Phosphor powder is used in lamps because it has a long afterglow.

3.1.4 Rotating machinery give a stroboscopic effect under incandescent lamps.

3.1.5 When compared with discharge lamps, tungsten halogen lamps emit bright light but consume a higher amount of energy.

(5 x 1) (5)

3.2 Draw a labelled circuit diagram of a fluorescent lamp that is started with the aid of a glow starter. (You will lose marks if the components are not labelled.) (5)

[10]

QUESTION 4: ALTERNATING CURRENT THEORY

4.1 FIGURE 4.1 shows a sine wave. NOTE: The angle is in degrees.

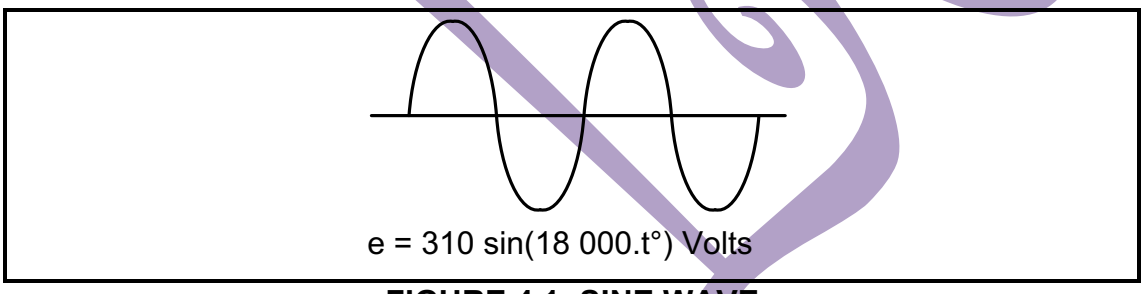


FIGURE 4.1: SINE WAVE

4.1.1 Calculate the waveform's effective value. (3)

4.1.2 Redraw the waveform indicating the RMS, peak and Average Values on the waveform correctly. (3)

4.2 Draw a phasor diagram that will represent a balanced three phase voltage supply. Indicate on the diagram the following:

- Correct order of Phases if the reference point is at 0°
- Correct Direction of Rotation
- Correct phase angle between phases
- Current in each phase lagging the voltage – Exact scale is not required. (4)

[10]

QUESTION 5: SERIES RLC CIRCUITS

5.1 FIGURE 5.1 shows an RLC Circuit. Answer the following questions.

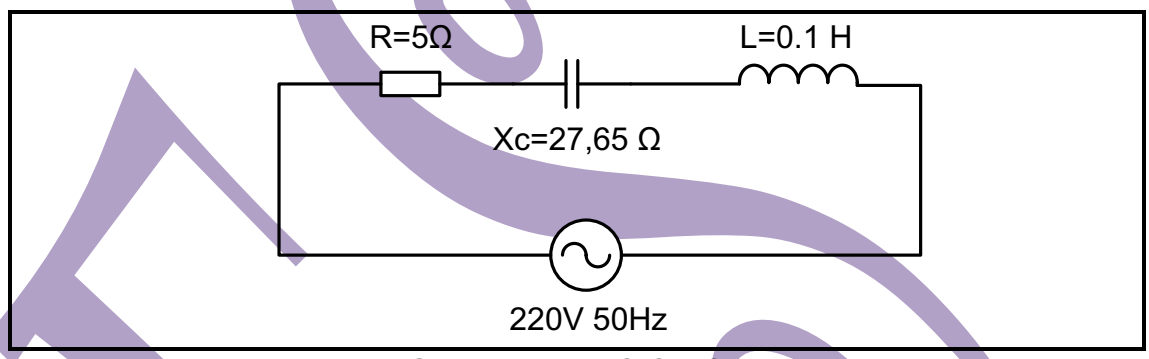


FIGURE 5.1: RLC CIRCUIT

5.1.1 Calculate the inductive reactance (3)

5.1.2 Calculate the circuit impedance. (3)

5.1.3 Sketch a fully labelled phasor diagram. (4)

[10]

QUESTION 6: THREE-PHASE AC SYSTEMS

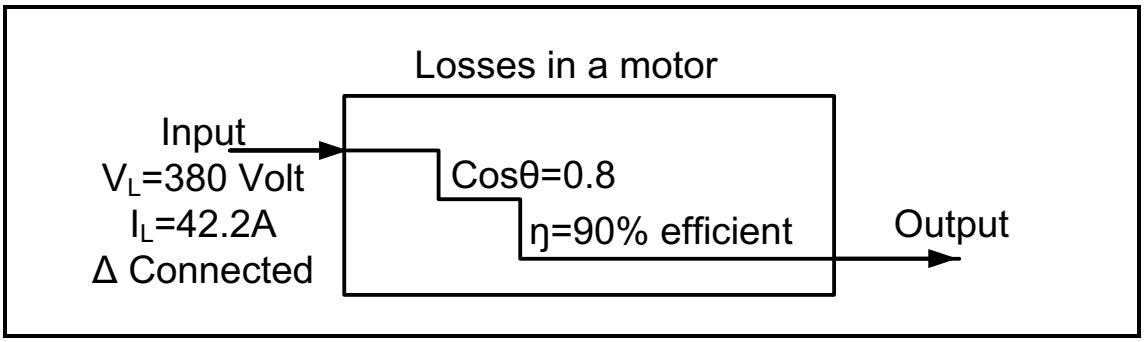
6.1 Calculate the power in balanced 3-phase delta connected system with the following information:

- Line Voltage = 420 Volt
- Line Current = 23A
- Φ=9°
- Load = inductive (3)

6.2 Calculate the line voltage between two phases in a star connected system if the phase voltage between one fase and neutral is 220 V. (3)

6.3 Figure 6.1 shows a block diagram representing the losses in a 3-phase motor.

Calculate the output power of the motor from the given information.



(4)

FIGURE 6.1: LOSSES IN A MOTOR

[10]

QUESTION 7: TRANSFORMERS

7.1 The circuit in FIGURE 7.1 below consists of three single-phase transformers connected together. This circuit is connected to a three-phase 380 V supply. The primaries are labelled with capital letters.

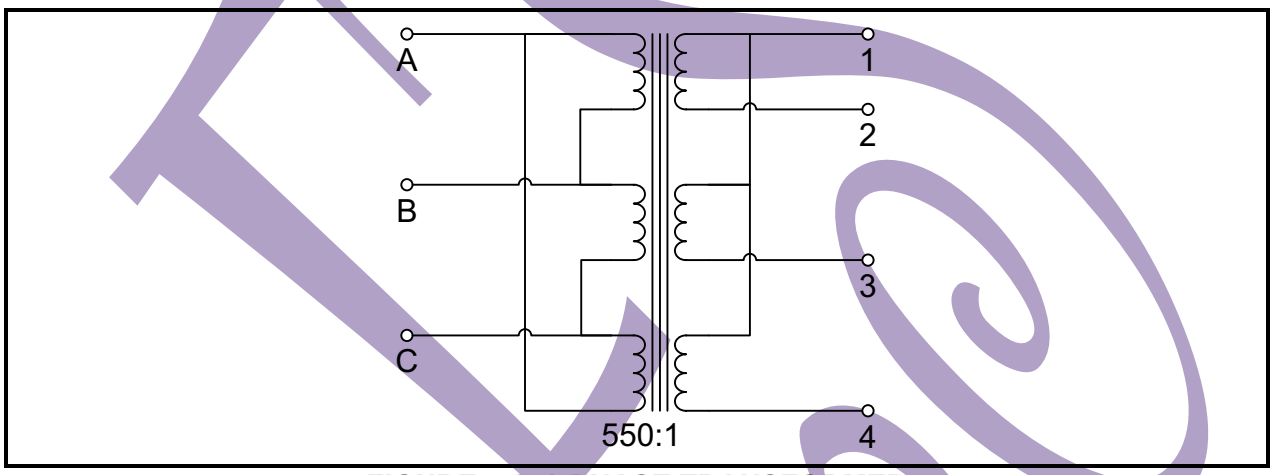


FIGURE 7.1: 3-PHASE TRANSFORMER

7.1.1 Identify the configuration in which the transformer is connected from primary to secondary. (2)

7.1.2 State whether this is a step up / step down transformer. (1)

7.1.3 Identify the Neutral connector/s on the transformer (1)

7.2 Calculate the output line voltage of a delta/delta step up transformer if the transformer has a turns ratio of 1:10 and an input line voltage of 380 Volts. (3)

7.3 A current of 2 A at a power factor of 0,8 is drawn from the 380 V supply when a transformer is connected to a balanced three-phase load.

Calculate the total power consumed. (3)

[10]

QUESTION 8: DC MACHINES

8.1 Name the functions of the following components of a DC motor circuit:

8.1.1 A variable resistor placed in series with the armature of a shunt motor

8.1.2 A no-volt release coil

8.1.3 An overload relay

(3 x 1) (3)

8.2 Name any TWO types of field-coil connections used in DC motors. (2)

8.3 Name any TWO methods to reduce armature reaction with reference to DC motors. (2)

8.4 Explain how you would do a field volt-drop test on a four-pole DC motor. (3)

[10]

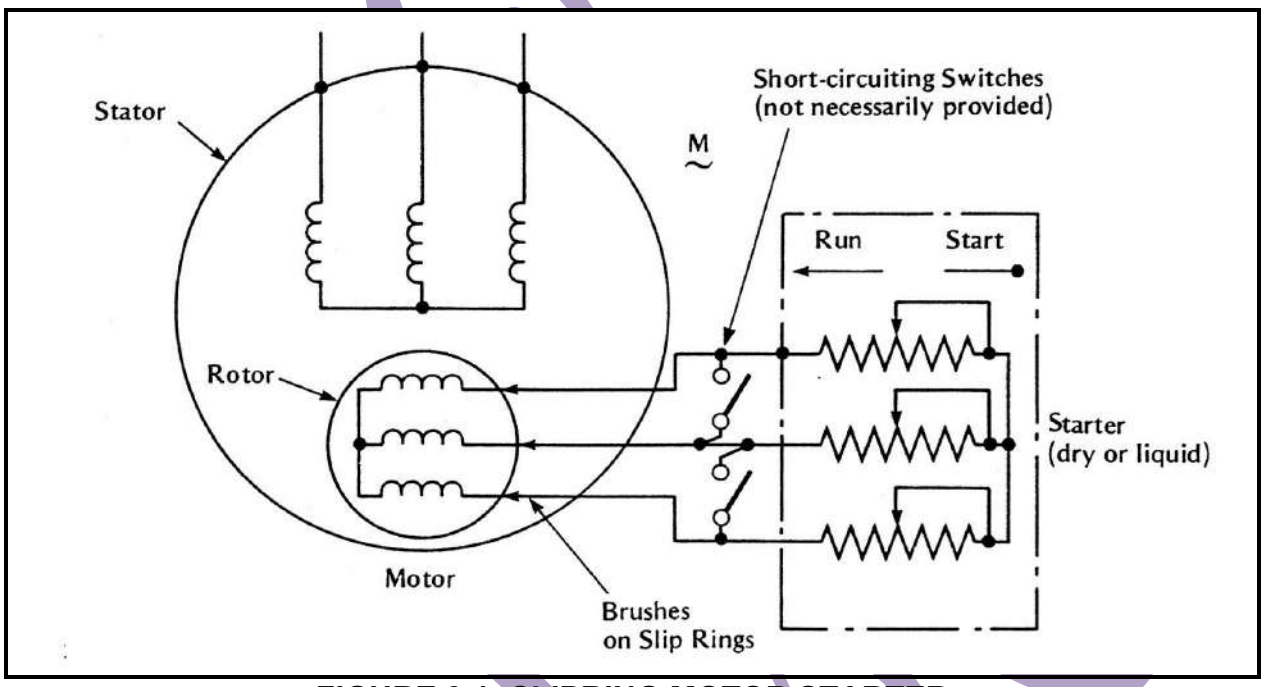
QUESTION 9: AC MACHINES

9.1 Explain why the running winding of a split-phase motor has a lower resistance and lower inductive reactance than the starting winding (2)

9.2 Draw a circuit diagram of a split-phase motor that has one capacitor which is permanently connected during operation. (3)

9.3 State the code of practice on motor circuits regarding the starter circuit of a large DC motor and loss of supply. (1)

9.4 Explain how the slip-ring motor in FIGURE 9.1 below is started and how it reaches full speed.



(4)

FIGURE 9.1: SLIPRING MOTOR STARTER

[10]

QUESTION 10: MEASURING INSTRUMENTS AND ELECTRONICS

10.1 Explain how you would increase the range of the following instruments:

10.1.1 A DC ammeter (1)

10.1.2 A DC voltmeter (1)

10.1.3 An AC wattmeter (3)

10.2 Define each of the following terms:

10.2.1 Electron current flow

10.2.2 Semi-conductor

10.2.3 Positive ions

10.2.4 P-type doping

10.2.5 Pentavalent atom

(5 x 1) (5)
[10]

TOTAL: 100

ELECTRICAL TRADE THEORY N3

FORMULA SHEET

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

$$I_{ACTIVE} = I_T \ Cos \ \phi$$

$$I_{REACTIVE} = I_T \ Sin \ \phi$$

$$X_L = 2\pi f L$$

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

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

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

$$V_R = I_T R$$

$$V_{XL} = I_T X_L$$

$$V_{XC} = I_T X_C$$

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

$$P = I^2 R$$

$$S = VI$$

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

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

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

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$$

$$\omega = 2\pi f$$

$$N = \frac{f.60}{p}$$

$$s = \frac{n - n_r}{n}$$

The next five formulae are true for voltage

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

$$I_{rms} = 0{,}707 \ I_m$$

$$I_{ave} = 0{,}637 \ I_m$$

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

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

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

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

SERIES

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

PARALLEL

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