GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

ELECTRICIANS WORK SG

POSSIBLE ANSWERS OCT / NOV 2006

QUESTION 1
ELECTRICAL CURRENT THEORY

1.1

1.1.1 Vrms = 0,707 x Vm (1)
= 0,707 x 60 (1)
= 42,42 volt (1)

$I = \frac{V}{R}$ (1)

$= \frac{42,42}{45}$

= 0,943 A or 943 mA (1)

[5]

1.1.2 $2\pi ft = 314\,t$ (1)

$f = \frac{314\,t}{2\pi\,\mathbf{t}}$ (1)

= 50 Hz (1)

[3]

1.1.3 e = 60 Sin (314 t) (1)
= $60 \text{ Sin } (314 \times 3 \times 10^{-3})$ (1)
= 60 Sin (0,942 rad) (1)
= 60 Sin (0,942 x 57,3) (1)
= 60 Sin 53,97 (1)
= 48,52 volt (1)

[6]

1.2 $F = \frac{1}{T}$ (1)

$= \frac{1}{20} \times 10^{-3}$ (1)

= 50 Hz (1)

i = Im sin 2 p ft (1)

5 = Im sin 2 p ft (1)

$Im = \frac{5}{\sin 2\pi \times 50 \times 5 \times 10^{-3}}$ (1)

= 182,4 A (1)

[7]

1.3 The total opposition impeding the passage of an alternating current in a circuit comprising combinations of resistances and reactances is called impedance. **[3]**

1.4

1.4.1

$XL = 2\,p\,FL$ (1)

$= 2\,p \times 100 \times 0{,}4$ (1)

$= 251{,}327$ ohm (1)

$XC = \dfrac{1}{2\,p\,FC}$ (1)

$XC = \dfrac{1}{2p \times 100 \times 160 \times 10^{-6}}$ (1)

$= 9{,}95$ ohms (1)

$Z = \sqrt{R^2 + (XL - XC)^2}$ (1)

$= \sqrt{20^2 + (251{,}33 - 9{,}95)^2}$ (1)

$= \sqrt{58\,664{,}13}$

$= 242{,}207$ ohm (1)

$I = \dfrac{V}{Z}$ (1)

$= \dfrac{100}{247{,}207}$ (1)

$= 0{,}413$ A (1)

[12]

1.4.2

$\cos Ø = \dfrac{R}{Z}$ (1)

$Ø = \cos^{-1} \dfrac{55}{242{,}207}$ (1)

$Ø = 76{,}87°$ (1)

[3]

1.4.3

$\cos Ø = \dfrac{R}{Z}$ (1)

$\cos Ø = \dfrac{55}{242{,}207}$

$\cos Ø = 0{,}227 = $ P.F (1)

[2]

1.4.4

I active $= I \cos Ø$ (1)

$= 0{,}403 \times 0{,}227$ (1)

$= 0{,}091$ A (1)

[3]

1.4.5

I reactive $= I \sin Ø$ (1)

$= 0{,}403 \times \sin 76{,}87$ (1)

$= 0{,}392$ A (1)

[3]

1.5 Bigger cables are needed to handle higher current. (1)

Switches, instruments must be able to handle the higher current. (1)

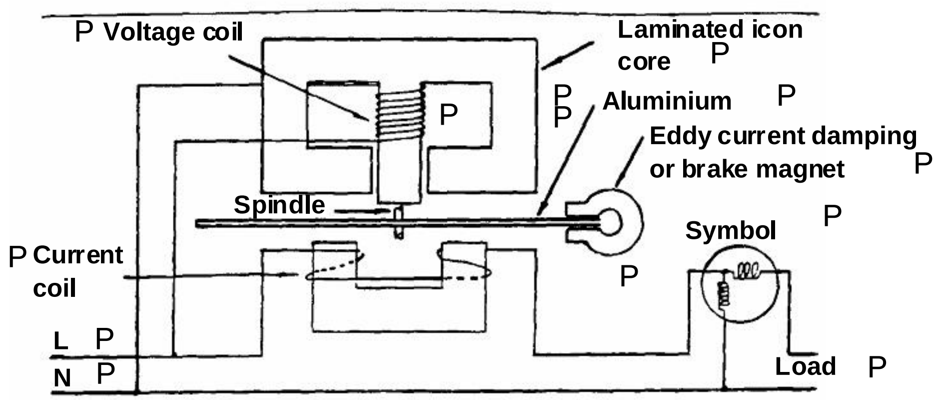
It causes a greater fall in the terminal voltage. (1)

[3]

[50]

QUESTION 2

2.1



[13]

2.2 Construction

It comprises a number of reeds (thin steel strips) 'tuned' to vibrate at different frequencies by varying their length. They are placed in front of a laminated iron core around which an exciting coil is wound. (3)

Operation

The exciting coil is connected across the supply of which the frequency is to be measured, which sets up an alternating flux. This alternating flux will cause the reed tuned to that frequency to vibrate and its tip, which is painted, will appear to be drawn out. The reeds close by will also vibrate but to a lesser extent. (4)

[20]

QUESTION 3

3.1

3.1.1 VP $= \frac{VL}{\sqrt{3}}$ (1)

$= \frac{380}{\sqrt{3}}$ (1)

$=$ 219,393 V (1)

IP $= \frac{VP}{R}$ (1)

$= \frac{219,393}{40}$

$=$ 5,485 A (1)

IL $=$ IP (1)

$=$ 606,06 A (1)

P $= \sqrt{3}$ x VL2 x IL2 x CosØ (1)

$= \sqrt{3}$ x 380 x 5,485 x 1 (1)

$=$ 3,85 kW (1)

[10]

3.1.2 VL $=$ VP (1)

$=$ 380 V (1)

IP $= \frac{VP}{R}$ (1)

$= \frac{380}{40}$

$=$ 9,5 A (1)

P $= \sqrt{3}$ x VL2 x IL2 x cosØ (1)

$= \sqrt{3}$ x 380 x 16,454 x 1 (1)

$=$ 10,83 kW (1)

IL $= \sqrt{3}$ x IPH (1)

IL2 $=$ 9,5 x $\sqrt{3}$

$=$ 16,454 A (1)

[9]

3.2

3.2.1 Efficiency $= \frac{\text{output}}{\text{input}} \times 100\%$ (1)

Pin $= \frac{\text{Pout}}{\text{Efficiency}}$ (1)

$= \frac{200\,000}{0,9}$ (1)

$=$ 222,222 kW (1)

Pin $= \sqrt{3}$ VL IL CosØ (1)

IL $= \frac{\text{Pin}}{\sqrt{3} \times \text{VL} \times \text{CosØ}}$ (1)

$= \frac{222\,222}{\sqrt{3} \times 500 \times 0,9}$ (1)

$=$ 285,112 A (1)

[8]

3.2.2 In delta IL $= \sqrt{3}$ x IPH (1)

$= \sqrt{3}$ x 285,112 (1)

$=$ 493,828 A (1)

[3]

[30]

QUESTION 4

4.1 To switch on the alarm when there is a fault. (1)
To isolate the transformer from the supply when there is a fault. (1)

[2]

4.2

4.2.1 $\frac{V1}{V2} = \frac{N1}{N2}$ (1)

$\frac{2\,000}{400} = \frac{N1}{150}$ (1)

N1 $= 2\,000 \times \frac{150}{400}$ (1)

N1 $=$ 750 turns (1)

[4]

4.2.2 S $=$ V1 x I1

I1 $= \frac{S}{V}$ (1)

$= \frac{120\,000}{2\,000}$ (1)

$=$ 60 A (1)

[3]

4.2.3

$$S = V2 \times I2$$

$$I2 = \frac{S}{V} \quad (1)$$

$$= \frac{120\,000}{400} \quad (1)$$

$$= 300 \text{ A} \quad (1)$$

[3]

4.3

4.3.1

$$VL = \sqrt{3} \times VP \quad (1)$$

$$VP = \frac{VL}{\sqrt{3}} \quad (1)$$

$$= \frac{380}{\sqrt{3}} \quad (1)$$

$$= 219{,}393 \text{ V} \quad (1)$$

[4]

4.3.2

$$VL = VP = 6\,000 \text{ V} \quad (1)$$

$$TR = \frac{V1p}{V2p} \quad (1)$$

$$= \frac{6\,000}{219{,}35} \quad (1)$$

$$= 27{,}35:1 \quad (1)$$

[4]

4.3.3

$$\frac{V1p}{V2p} = \frac{N1}{N2} \quad (1)$$

$$\frac{6\,000}{219{,}393} = \frac{3\,000}{N2} \quad (1)$$

$$N2 = \frac{3\,000 \times 219{,}393}{6\,000} \quad (1)$$

$$N2 = 109{,}696 \text{ turns} \quad (1)$$

[4]

4.3.4

$$IL = \sqrt{3} \times IP \quad (1)$$

$$IP = \frac{IL}{\sqrt{3}} \quad (1)$$

$$= \frac{25}{\sqrt{3}} \quad (1)$$

$$= 20{,}21 \text{ A} \quad (1)$$

[4]

4.4

1. Copper losses (1)
2. Iron losses (1)

[2]

[30]

QUESTION 5

5.1 The speed of rotation of the magnetic flux is called synchronous speed. (2)

The speed that the rotor rotates is called the rotor speed and is always less than the synchronous speed. (2)

[4]

5.2
1. Insulation Resistance Test between Windings
2. Insulation Resistance to Earth Test
3. Short Circuit and Open Circuit Test **[3]**

5.3

$$\text{Input} = \frac{\text{Output}}{\text{Efficiency x } 100\%} \quad (1)$$

$$= \frac{15\,000}{0{,}8} \quad (1)$$

$$= 18\,750 \text{ W}$$

$$= 18{,}750 \text{ kW} \quad (1)$$

$$I = \frac{P}{\sqrt{3} \text{ x V x } \cos Ø} \quad (1)$$

$$= \frac{18\,750}{\sqrt{3} \text{ x } 380 \text{ x } 0{,}9} \quad (1)$$

$$= \frac{18\,750}{526{,}54} \quad (1)$$

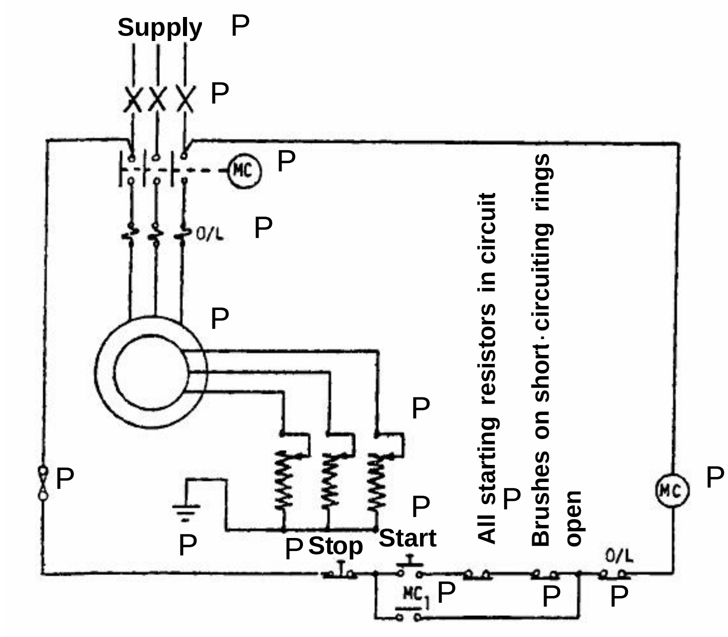
$$= 31{,}653 \text{ A} \quad (1)$$

$$7\% = \frac{31{,}653 \text{ x } 7}{100} = 2{,}216 \text{ A} \quad (2)$$

Current value on overload = 31,653 + 2,216 = 33,869 (1)

[10]

5.4



Resistance starter for a slip-ring motor **[15]**

5.5 It is much more expensive than an ordinary induction motor.
It has a low starting torque.
It requires more auxiliary equipment.
It can only be operated by trained personnel. **[4]**

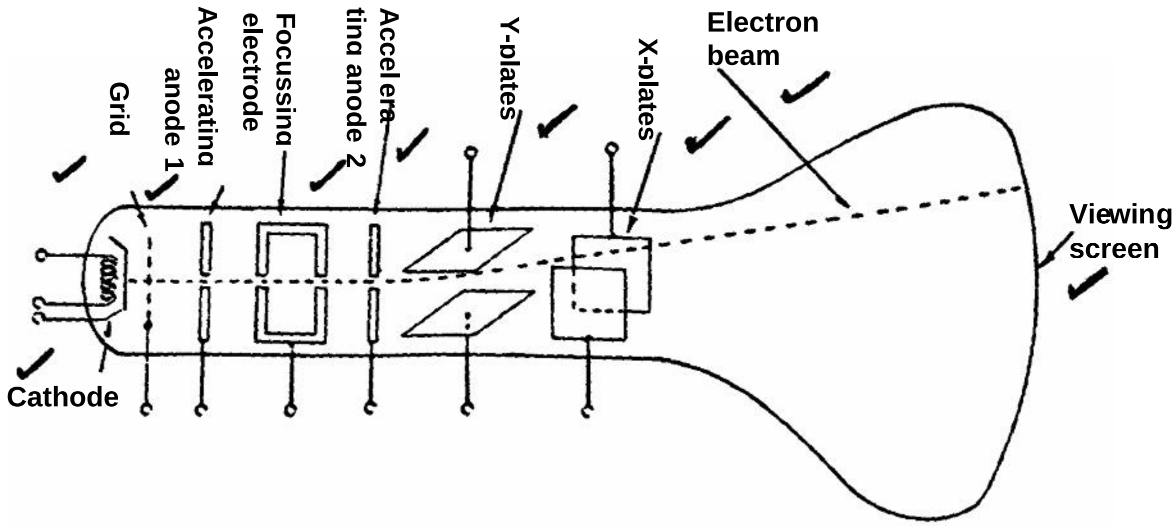
5.6 Frequency
No of pole pairs **[2]**

5.7 The direction of rotation may be reversed by interchanging any two supply lines on the motor or starter terminals. **[2]**

[40]

QUESTION 6

6.1



(9)

6.2
1. Both current and voltage are amplified and therefore this can be regarded as a power amplifier.
2. The signal is inverted with respect to the input signal.
3. The input and output impedance are in the medium range, i.e. between approximately 1,5 and 5 kilo-ohms. **[3]**

6.3 The transistor is connected to the supply with the emitter to the negative and the collector to the positive. For conduction to take place the base must be made positive with respect to the emitter, the transistor is in the "cut-off" or non-conduction condition. **[4]**

6.4 To keep the voltage in the circuit constant when the current is variable and is able to withstand relatively high currents without the P-N junction being destroyed. **[2]**

6.5 By changing the potential of one set of plates to either maximum positive position or maximum negative position. **[2]**

[20]

QUESTION 7

7.1
1. Switch off the power supply. (1)
2. If the supply cannot be switched off, the person must be pulled away using an insulated material. (1)
3. If necessary, the conductors must be cut with pliers or hexed off with an axe. (1)
4. Ensure that you do not get shocked as well. (1)
5. Examine the person and if necessary you can perform basic first-aid treatment or call a doctor. (1)

[5]

7.2
1. Unsafe circumstances
2. Wrong attitude
3. Physical or mental indisposition
4. Lack of knowledge and skill
5. Incorrect usage of equipment [Any suitable answer] **[5]**

[10]

TOTAL: 200