Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2018

ELECTRICAL TECHNOLOGY: POWER SYSTEMS MARKING GUIDELINE

MARKS: **200**

This marking guideline consists of 11 pages.

INSTRUCTIONS TO THE MARKERS

1. All questions with multiple answers imply that any relevant, acceptable answer should be considered.

2. Calculations:

   2.1 All calculations must show the formulae.

   2.2 Substitution of values must be done correctly.

   2.3 All answers MUST contain the correct unit to be considered.

   2.4 Alternative methods must be considered, provided that the correct answer is obtained.

   2.5 Where an incorrect answer could be carried over to the next step, the first answer will be deemed incorrect. However, should the incorrect answer be carried over correctly, the marker has to re- calculate the values, using the incorrect answer from the first calculation. If correctly used, the candidate should receive the full marks for subsequent calculations.

   2.6 Markers should consider that candidates' answers may deviate slightly from the marking a guideline depending on how and where in the calculation rounding off was used.

3. These marking guidelines are only a guide with model answers.

4. Alternative interpretations must be considered and marked on merit. However, this principle should be applied consistently throughout the marking session at ALL marking centres.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 A badly planned ✓
Unorganised workshop. (Any ONE relevant answer.) (1)

1.2 Good housekeeping will ensure a safer and better organised workshop. ✓ A safer working environment allows for better profits, higher productivity, a happier workforce and saves time. ✓ (2)

1.3 By installing machine guards, ✓ barrier guards ✓ and shields. ✓ (3)
[6]

QUESTION 2: THREE-PHASE AC GENERATION

2.1 It is a joint with no proper contact between the component and the track ✓ causing an irregular or broken connection ✓ (2)

2.2
- To measure AC and DC voltage. ✓
- Analyse relationship between waveforms. ✓
- Measure the frequency of the waveforms. (2)

2.3 An insulation resistance tester can measure very high resistance as required by the Code of Practice. ✓
The voltage to be used to test insulation levels should be double the supply voltage. ✓ (2)
[6]

QUESTION 3: DC MACHINES

3.1
- Copper losses ✓
- Iron losses ✓
- Mechanical losses ✓ (3)

3.2 It is built up of thin laminated circular steel plates to reduce eddy current losses. ✓
It is provided with slots in which the armature windings are placed. ✓
It may be provided with air ducts for the axial flow of air for cooling purposes. (2)

3.3 By swopping the connections of either the field windings or the armature, ✓ but NOT both ✓ (2)

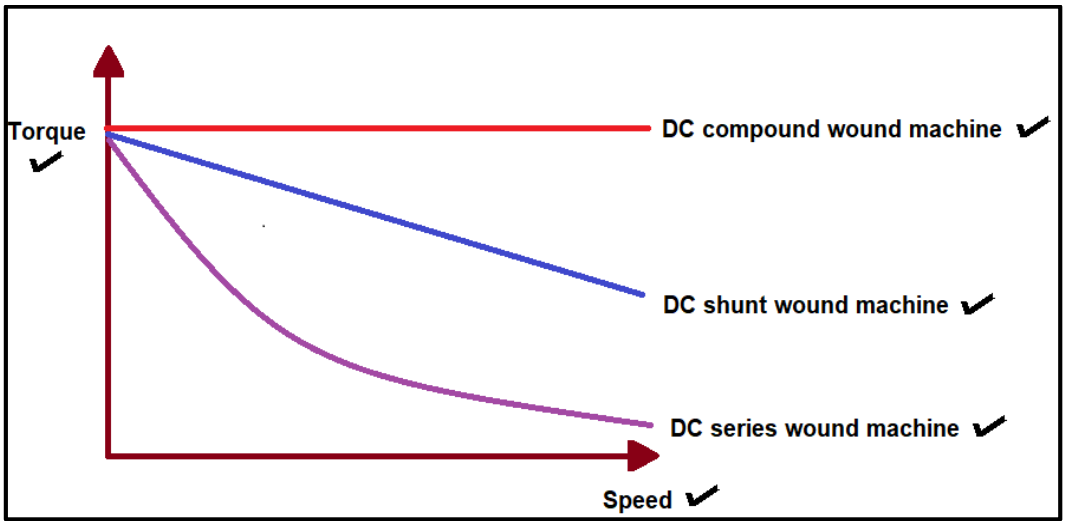
3.4.1 $\text{number of parallel paths} = 2p$ ✓$= 2 \times 4 = 8$ ✓
$\text{no of conductors per path} = \frac{768}{8}$ ✓
$= 96 \text{ conductors}$ ✓ (4)

3.4.2 $\text{number of parallel paths} = 2$ ✓
$\text{number of conductors per path} = \frac{768}{2}$ ✓
$= 384 \text{ conductors}$ ✓ (3)

3.5 The speed control ✓
The speed is directly proportional to armature voltage and inversely proportional to the magnetic flux produced by the pole, ✓ meaning adjusting the armature voltage and / or the field current will change the rotor speed. ✓ (3)

3.6
- Mechanical test ✓
- Electrical test ✓ (2)

3.7



(5)

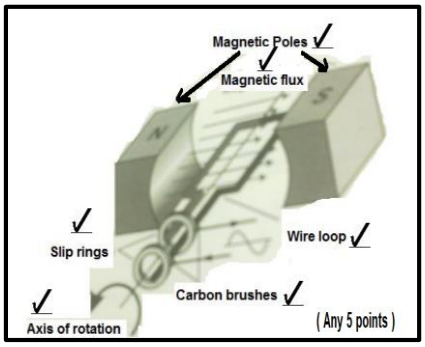
3.8 Compensating windings ✓
Inter-poles ✓ (2)
[26]

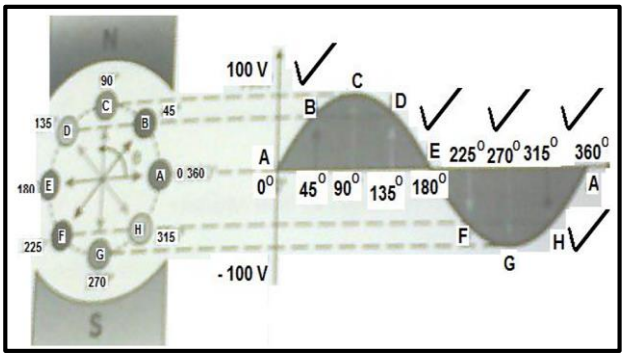
QUESTION 4: SINGLE-PHASE AC GENERATION

4.1 Root-Mean-Square is the AC value of a sine wave that is required ✓ for producing the same heat as the same DC voltage value. ✓ (2)

4.2 Alternating current is when the current reverses its direction at constant intervals of time. ✓ Direct current is when the current flows in one direction only. ✓ (2)

4.3





(7)

OR

The mechanical rotation energy is transformed into electrical energy, ✓ which is then distributed to the point of consumption. ✓

4.4 $\emptyset = \beta . A$ ✓
$= 3 \times 900 \times 10^{-6}$ ✓
$= 0{,}0027Wb = 2{,}7mWb$ ✓ (3)

4.5 4.5.1 The generated EMF is directly proportional ✓ to the number of windings. ✓ (2)

4.5.2 If more pole pairs are added, then for each revolution more cycles will be generated ✓ increasing the frequency ✓ (2)

4.5.3 Laminated cores reduce Eddy currents induced in the core ✓ thereby making the coil more efficient. ✓ (2)

4.6 $V_{rms} = V_{max} \times 0{,}707$ ✓
$= 75 \times 0{,}707$ ✓
$= 53{,}03\ V$ ✓

$V_{ave} = V_{max} \times 0{,}637$ ✓
$= 75 \times 0{,}637$ ✓
$= 47{,}78\ V$ ✓ (6)

[26]

QUESTION 5: SINGLE-PHASE TRANSFORMERS

5.1 Transformers are rated according to their apparent power (VA).✓ (1)

5.2 Copper losses (I^2R losses) Eddy Current losses (Heat losses) ✓
Dielectric losses ✓ Iron losses (Hysteresis losses) (3)

5.3 CT-safely measures the current in a high current power lines. ✓
PT-safely measures the voltage in a high voltage power lines. ✓ (2)

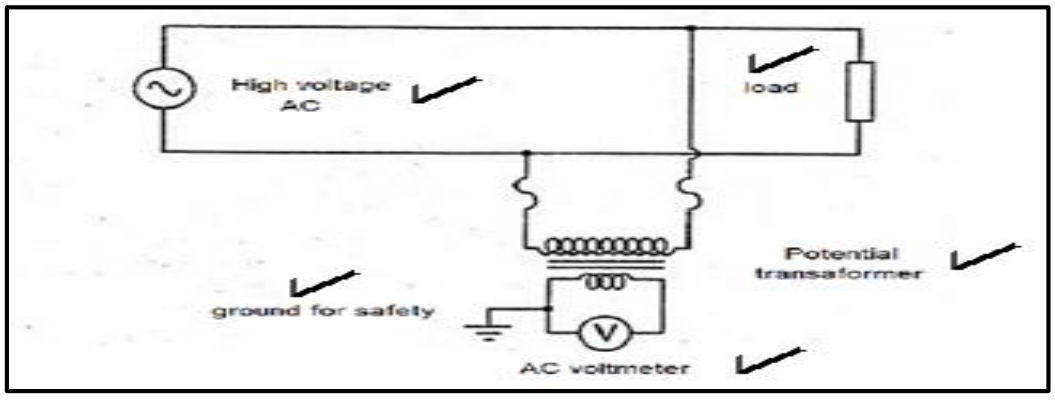
5.4 t is used as a safety device to provide protection against electric shock from the mains ✓ while at the same time transferring electric power between two circuits which must not be directly connected. ✓ (2)

5.5 5.5.1 $t.ratio = \frac{V_p}{V_s}$ ✓
$= 220 : 24$ ✓
$= 9{,}17 : 1$ ✓ (3)

5.5.2 $R = \frac{V}{I}$ ✓
$= \frac{24}{2}$ ✓
$= 12\ \Omega$ ✓ (3)

5.5.3 $\frac{V_P}{V_S} = \frac{I_S}{I_P}$
$I_P = \frac{I_S \times V_S}{V_P}$ ✓
$= \frac{2 \times 24}{220}$ ✓
$= 0{,}218\ A = 218\ mA$ ✓ (3)

5.6



(5)

5.7 When an alternating emf is applied to the primary winding, ✓an alternating magnetic field is set up around the primary winding. ✓
This alternating magnetic field induces an alternating emf in the secondary winding. ✓ The magnitude of this induced emf depends upon the transformation ratio of the transformer. ✓ (4)

[26]

QUESTION 6: RLC CIRCUITS

6.1 6.1.1 Reactance increases. ✓ (1)

6.1.2 Reactance decreases. ✓ (1)

6.2 6.2.1 $C = \frac{1}{2\pi f X_C}$ ✓
$= \frac{1}{2\pi \times 50 \times 157}$ ✓
$= 20{,}27\mu F$ ✓ (3)

6.2.2 $Q = \frac{X_L}{R}$ ✓
$= \frac{157}{4}$ ✓
$= 39{,}25$ ✓ (3)

6.3 6.3.1 The effect at resonant frequency is that reactance is zero so Z=R ✓
Impedance is therefore at a minimum at point A. ✓ (2)

6.3.2 $f_r = \frac{1}{2\pi\sqrt{LC}}$ ✓
$= \frac{1}{2\pi \times \sqrt{0{,}1 \times 50 \times 10^{-6}}}$ ✓
$= 71{,}18\ Hz$ ✓ (3)

6.4 6.4.1 $Z = \sqrt{R^2 + (X_L - X_C)^2}$ ✓
$= \sqrt{30^2 + (40 - 20)^2}$ ✓
$= 36{,}05\ \Omega$ ✓ (3)

6.4.2 $\theta = cos^{-1}\frac{R}{Z}$ ✓
$= cos^{-1}\left(\frac{30}{36{,}05}\right)$ ✓
$= 33{,}68°$ ✓ lagging ✓ (4)

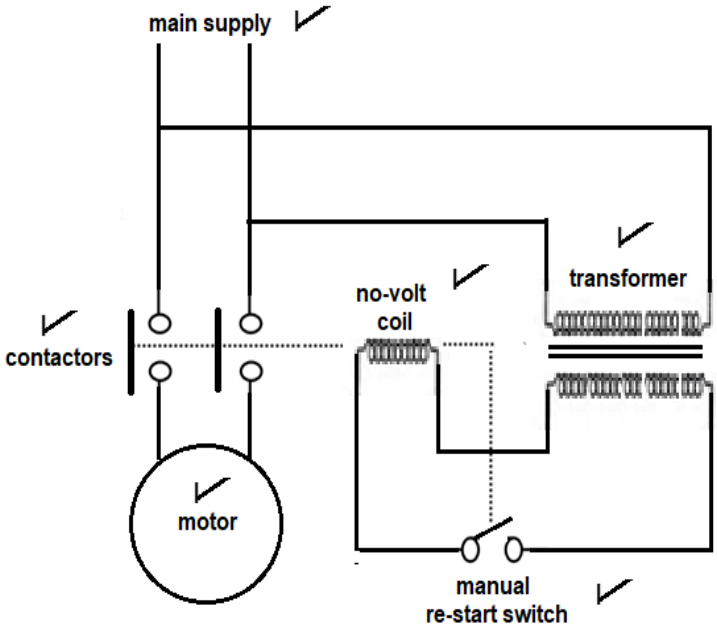
[20]

QUESTION 7: CONTROL DEVICES

7.1 The bi-metallic strip size, shape, ✓ and the material it is made of. ✓ (2)

7.2 Hardware is all the parts of PLC that you can see, (CPU, monitors, input devices and output devices) ✓✓
Software is the machine language that is installed on a computer or written into a PLC's control. ✓✓ (4)

7.3



(6)

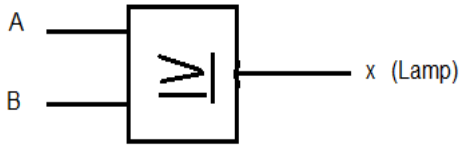
7.4 In the event of power cut ✓ the motor cannot self-start when power is restored. ✓ (2)

7.5 Overload ✓
Short – circuit ✓
Ground or earth fault ✓ (3)

7.6 At normal operating temperature, the conductive particles form low resistance paths through the polymer beads. ✓
If the temperature rises above the PTC designed limits, the crystallites in the polymer melt and become a shapeless mass, increasing their volume. ✓
This pushes the conductive particles apart causing the two temperature to rise and PTC 'trips' causing the current flow to fall to a safe level, protecting the equipment. ✓ (3)

7.7.1 OR gate. ✓ (1)

7.7.2



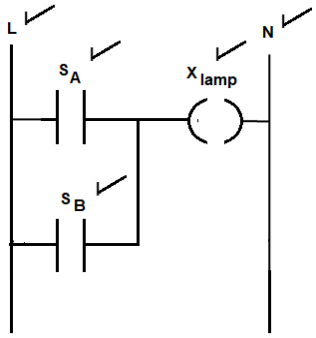
✓✓ (2)

7.7.3

input		output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

✓✓ (2)

7.7.4



(5)

7.8 Set input OTL (latch) ✓
Reset input OTU (unlatch) ✓ (2)

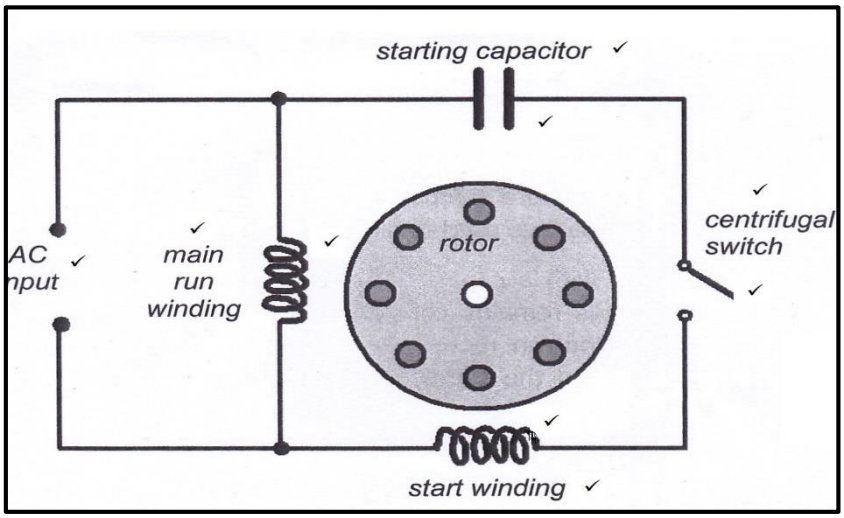
[32]

QUESTION 8: SINGLE-PHASE MOTORS

8.1 To automatically disconnect the supply ✓ in the event of an overload ✓ (2)

8.2
- Rotor ✓
- Stator ✓
- End plates ✓ (3)

8.3



(9)

8.4 Mechanical test ✓
Electrical test ✓ (2)

8.5 Have a high starting torque ✓
Quiet in operation ✓ (2)

8.6 By swopping the connections of either the start or run windings, ✓ but NOT both ✓ (2)

8.7 It is a motor that has its speed synchronised with the frequency of the mains supply. ✓ It spins at exactly the same rate ✓ as the incoming frequency. ✓ (3)

8.8.1 To measure the resistance of the windings. ✓ (1)

8.8.2 Insulation resistance test between conductors. ✓
Insulation resistance test between conductors and earth. ✓ (2)

8.8.3 Insulation tester or megger. ✓ (1)

8.8.4 At least 1MΩ. ✓ (1)

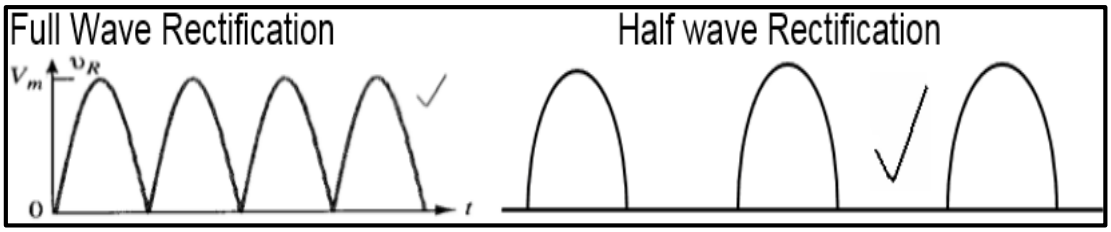
8.9 A universal motor is able to operate on an AC supply because of the way it is wired, with its two stator field coils connected in series ✓ with the rotor windings through its commutator. ✓ (2)

8.10 washing machines ✓
fans ✓ (2)

[32]

QUESTION 9: POWER SUPPLIES

9.1

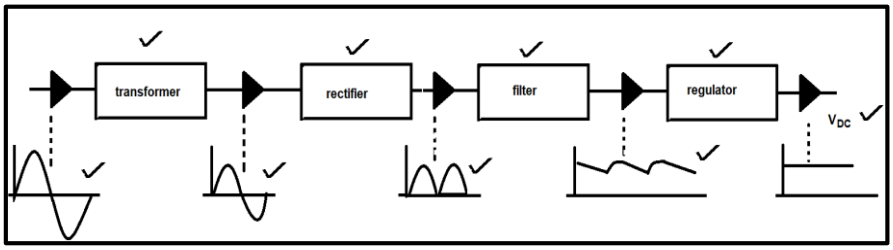


(2)

9.2
- Transformer ✓
- Rectifier ✓
- Smoothing ✓
- Regulation ✓

(4)

9.3



(Any 8 marks) (8)

9.4.1 $E_{PK} = \frac{E_{RMS}}{0,707}$ ✓
$= \frac{23}{0,707}$ ✓
$= 32,53\ V$ ✓ (3)

9.4.2 $V_{PK} = E_{PK} - V_D$ ✓
$= 32,53 - 0,6$ ✓
$= 31,93\ V$ ✓ (3)

9.4.3 $V_{AVE} = V_{DC} = 0,318 \times V_{PK}$ ✓
$= 0,318 \times 31,93$ ✓
$= 10,15\ V$ ✓ (3)

9.5 On each input cycle the diodes allow pulses of charge to enter the capacitor. ✓ During the periods in each cycle that the diodes are off, the capacitor discharges its energy into the load, ✓ keeping the supply constant for the full cycle. ✓ (3)

[26]

TOTAL: 200