Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2015

ELECTRICAL TECHNOLOGY MEMORANDUM

MARKS: 200

This memorandum consists of 11 pages.

INSTRUCTIONS TO 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 formula(e).

   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 same answer is obtained.

   2.5 Where an erroneous 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 learner should receive the full marks for subsequent calculations.

3. The memorandum is only a guide with model answers. Alternative interpretations must be considered and marked on merit. However, this principle should be applied consistently throughout.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1
- The etching of printed circuit boards. √
- The use of power tools. √
- Incorrect use of hand tools. √ (Any 2 x 1) (2)

1.2
- E-mails √
- Internet access √
- Telephone calls √
- Data √
- Images √ (Any 1 x 1) (1)

1.3 Honesty, √ self-discipline, √ reliability √ and loyalty √ are desirable traits or characteristics. (Any 3 x 1) (3)

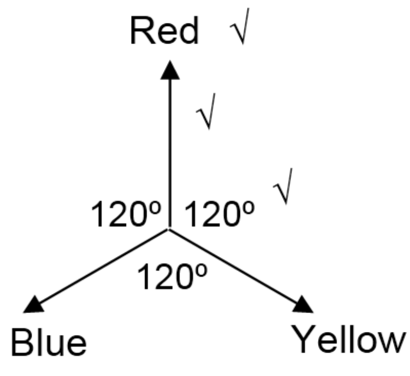
1.4
- Respecting the rights of others. √
- Being a team worker. √
- Being co-operative. √
- Being assertive. √
- Displaying a positive customer service attitude. √
- Seeking opportunities for continuous learning. √
- Demonstrating polite behaviour. √
- Respecting confidentiality. √ (Any 2 x 1) (2)

1.5 Assess hazards √ and make sure the area is safe. √ (2)

[10]

QUESTION 2: THREE-PHASE AC GENERATION

2.1



(3)

2.2
- Can be connected in star or delta.
- Two voltages available (V_L and V_{PH}). √
- For three-phase and single-phase alternators of similar physical sizes, three-phase will generate more power. √
- Three-phase supply power to single and three-phase loads. √
- Three-phase is cheaper to generate. √
- Three-phase requires less maintenance. √

(Any 3 relevant advantages x 1) (3)

2.3 $V_L = V_{PH}$ √= 220 V √

$I_{PH} = \frac{V_{PH}}{Z}$ √ $= \frac{220}{44}$ √ = 5 A√

$I_L = \sqrt{3}I_{PH}$ √ $= \sqrt{3{,}5}$ √ = 8,66 A √ (8)

2.4 Active power that is effectively being used by the load or the circuit. √ Reactive power is the power that is wasted and not used to do work on the load. √ (2)

2.5 The copper windings of the alternators have both resistance and inductance, √ and each phase will have a certain impedance. √ It is of utmost importance that the rotating coils generate the same voltages and currents in each phase, √ and that is only possible if the impedance of all three phases are matched. √ (4)

[20]

QUESTION 3: THREE-PHASE TRANSFORMERS

3.1 3.1.1 T √ (1)

3.1.2 T √ (1)

3.1.3 F √ (1)

3.1.4 T √ (1)

3.1.5 T √ (1)

3.1.6 T √ (1)

3.2 3.2.1 $V_L = V_{PH}$ = 11 Kv √

$\frac{V_{SEC}}{V_{PRIM}} = \frac{N_S}{N_P}$ √

$V_{SEC\ (PH)} = \frac{11\ 000 \times 3}{150}$ √ = 220 V √ (4)

3.2.2 $P_{ACT} = \sqrt{3}\ V_L\ I_L \cos\theta$ √

$I_L = \frac{P_{ACT}}{\sqrt{3}\ V_L \cos\theta}$ √

$V_L = \sqrt{3}\ V_{PH}$ = $\sqrt{3} \times 220$ √ = 381,7 V √

$I_L = \frac{12\ 000}{\sqrt{3} \times 381{,}7 \times 0{,}8}$ √

= 22,65 A (6)

3.3 3.3.1 Yes √ (1)

3.3.2
- Air cooled √
- Oil cooled √
- Water cooled √ (3)

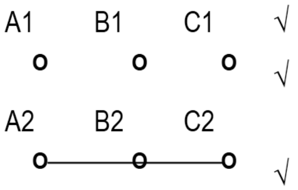
[20]

QUESTION 4: THREE-PHASE MOTORS AND STARTERS

4.1
- Self-starting √
- Robust √
- Simple construction √
- Low maintenance √
- Reduced fire risk √
- Reduced running cost √
- High starting torque √
- Wide range of applications √
- Easy to change direction of rotation √
- Can be star or delta connected √
- High efficiency √
- Higher power factor √
- Wide range of power ratings √ (Any 3 x 1) (3)

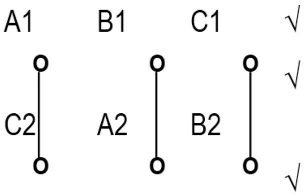
4.2 Rotor, √ Stator, √ Stator windings (or endplates) √ (3)

4.3 4.3.1



STAR (3)

4.3.2



DELTA (3)

4.4 4.4.1

$P_{APP} = \frac{P_{ACTIVE}}{\text{Cos } \theta}$ √ $= \frac{50\,000}{0,9}$ √ $=$ 55,5556 kVA √ (3)

4.4.2

$I_L = \frac{P_{ACTIVE}}{\sqrt{3}\, V_L \text{ Cos } \theta}$ √

$= \frac{50000}{\sqrt{3}\,(380)\,(0,9)}$ √

$=$ 84,41 A √ (3)

4.4.3

$NS = \frac{60 \times f}{P}$ √

$= \frac{60 \times 50}{2}$ √ (4 poles/ phase = 2 Pole Pairs) √

$=$ 1500 RPM √ (4)

4.4.4

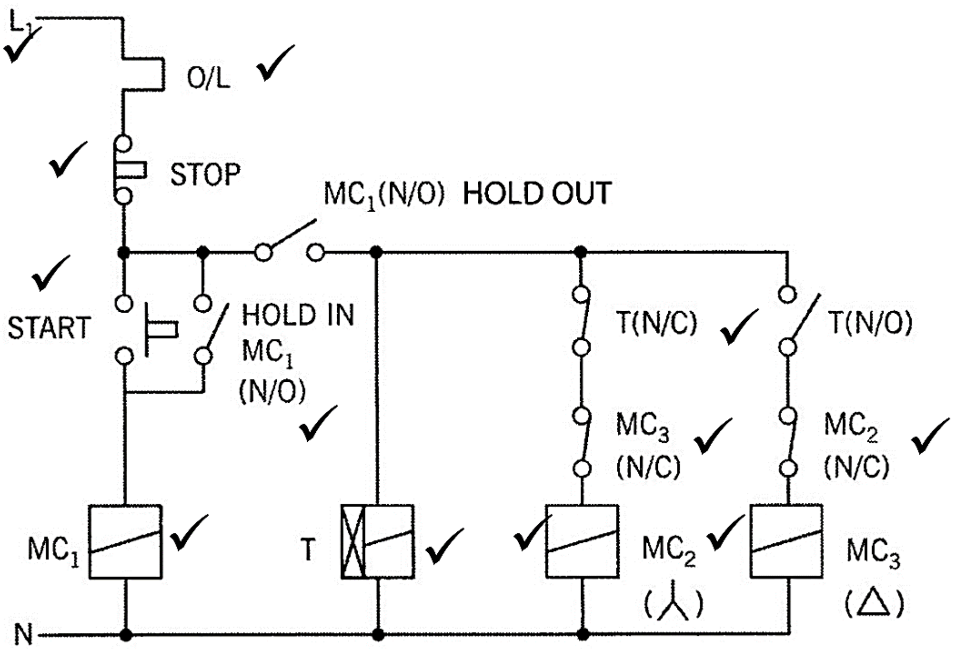
$\text{SLIP} = \frac{(N_S - N_R) \times 100}{N_S}$ √ $= \frac{(1500 - 1400) \times 100}{150}$ √ $= 6,67\%$ √ (3)

4.4.5 $\eta = \frac{P_{OUT} \times 100\%}{P_{IN}}$ √

$= \frac{45 \text{ kW} \times 100}{50 \text{ kW}}$ √

$= 90\%$ √ (3)

4.5



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QUESTION 5: RLC CIRCUITS

5.1 5.1.1 No effect √ (1)

5.1.2 Inductive Reactance is proportional to the frequency ($X_L = 2\pi fL$) √ (1)

5.1.3 Capacitive Reactance is inversely proportional to frequency ($X_C = 1/(2\pi fC)$) √ (1)

5.2 Impedance is the total opposition √ to the flow of current √ in an AC circuit. √ (3)

5.3 5.3.1 $I_R = \frac{V_S}{R} = \frac{110}{47}$ √ $= 2.340$ A √

$I_L = \frac{V_S}{X_L} = \frac{110}{70}$ √ $= 1.571$ A √

$I_C = \frac{V_S}{X_C} = \frac{110}{80}$ √ $= 1.357$ A √

$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$

$= \sqrt{2.34^2 + (1.571 - 1.357)^2}$ √

$= 2.35$ A √ (8)

5.3.2 $Z = \frac{V_S}{I_T} = \frac{110}{2,35}$ √ $= 46,813\ \Omega$ √ (2)

5.4 At resonance a parallel RLC circuit draws minimum current, √ whereas a series circuit draws maximum current. √ The parallel circuit would be better √ because the circuit would be tuned to the resonant frequency for longer. √ (4)

[20]

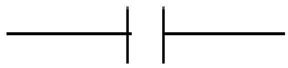
QUESTION 6: LOGIC

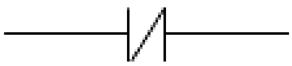
6.1 Programmable Logic Controller (1)

6.2 6.2.1
- Push buttons √
- Contacts √
- Limit switches √
- Sensors √ (Any 2 x 1) (2)

6.2.2
- Solenoids √
- Contactors √
- Alarms √ (Any 2 x 1) (2)

6.3 Manufacturing, √ machining, √ food/beverage, √ metal, √ power, √ mining, √ petrochemical/chemical √ (Any 1 x 1) (1)

6.4 6.4.1  √ (1)

6.4.2  √ (1)

6.4.3  √ (1)

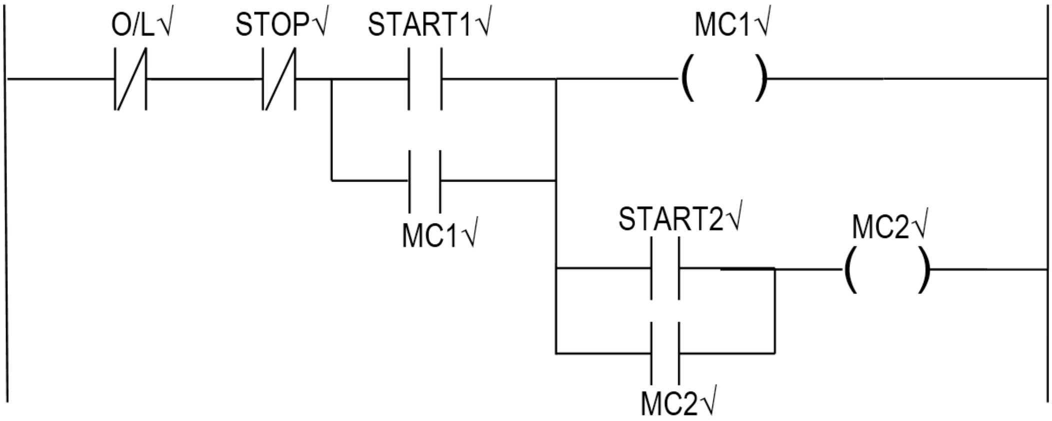
6.5
- Checking the inputs – (INPUT)
- Execution of instructions – (PROCESS)
- Updating the outputs – (OUTPUT) (3)

6.6

A√ \ BC√	00	01	11	10
0	0	0	0	0
1	1√	1√	1√	1√ √

= A √ (8)

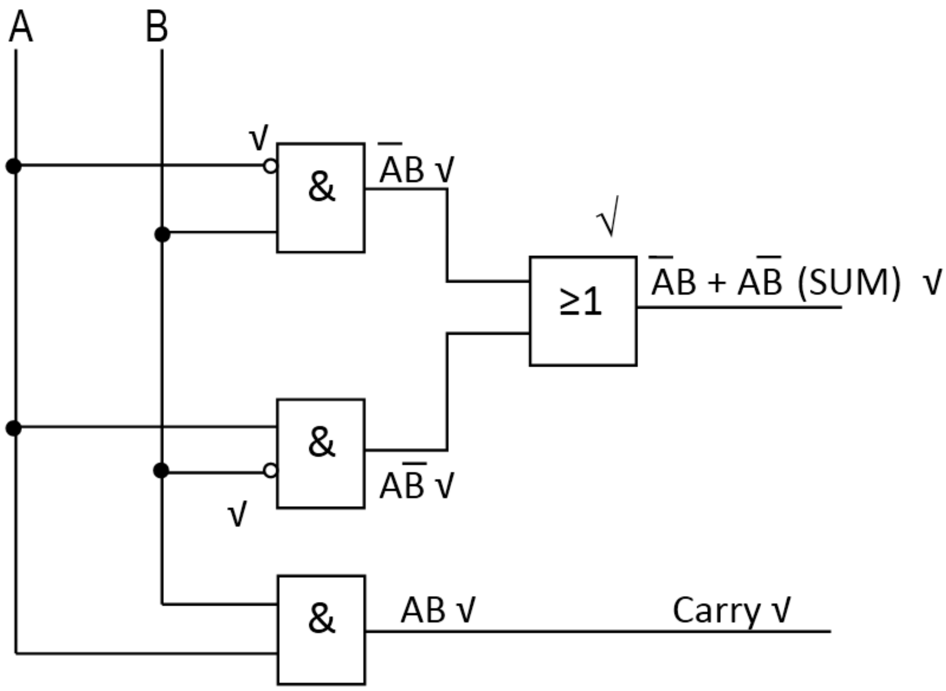
6.7



(8)

6.8 6.8.1 SUM √ = $\overline{A}B + A\overline{B}$ √
Carry √ = AB √ (4)

6.8.2



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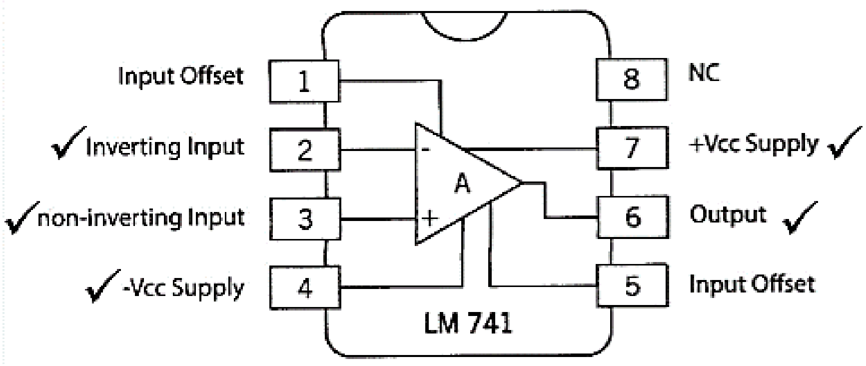
QUESTION 7: AMPLIFIERS

7.1



(5)

7.2 Amplifies both AC and DC √ without any loss in Gain. √ (2)

7.3
- Increase in bandwidth. √
- Increased stability. √
- Reduces distortion and noise. √
- Improved input and output impedances. √
- Allow design for a specific gain. √ (Any 3 x 1) (3)

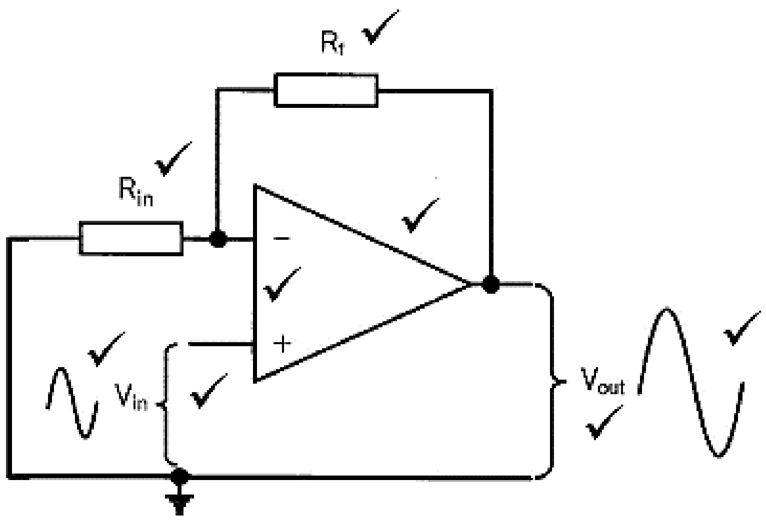
7.4
- Zero Level Detector √
- Threshold detector √
- Null detectors √ (Any 2 x 1) (2)

7.5 7.5.1 0 V (1)

7.5.2 Approximately +15 V (1)

7.5.3 Approximately -15 V (1)

7.6



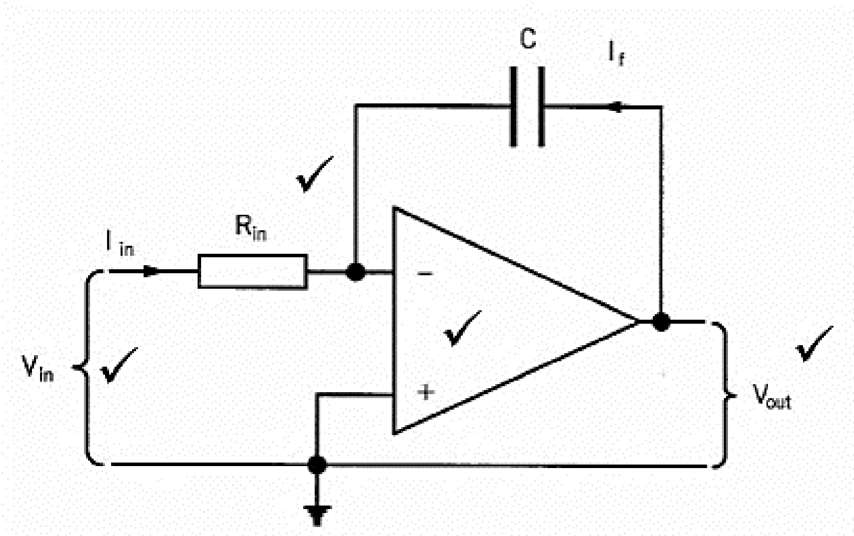
(8)

7.7 $V_{OUT} = V_{IN}\left(1 + \frac{R_F}{R_{IN}}\right)$ √

$= 3\left(1 + \frac{100K}{10K}\right)$ √

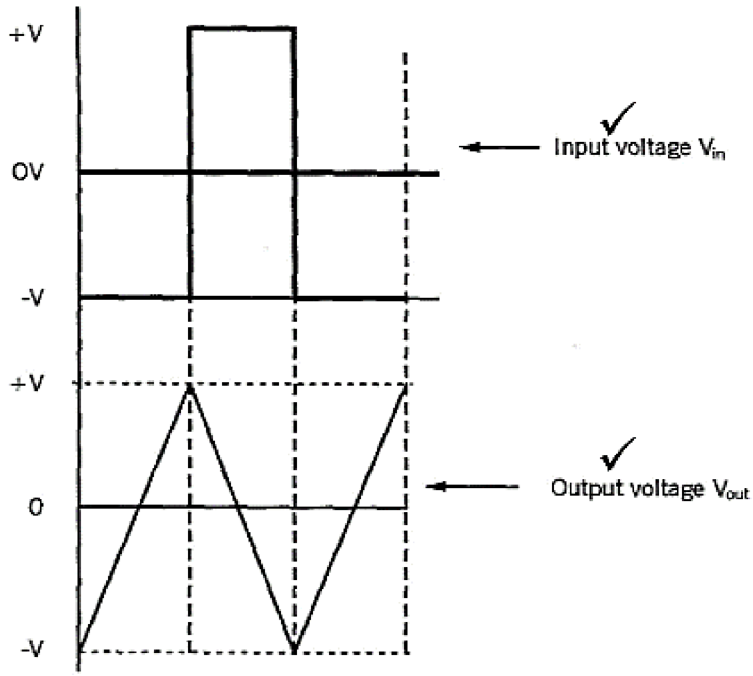
$= 33V$ √ (3)

7.8



(5)

7.9



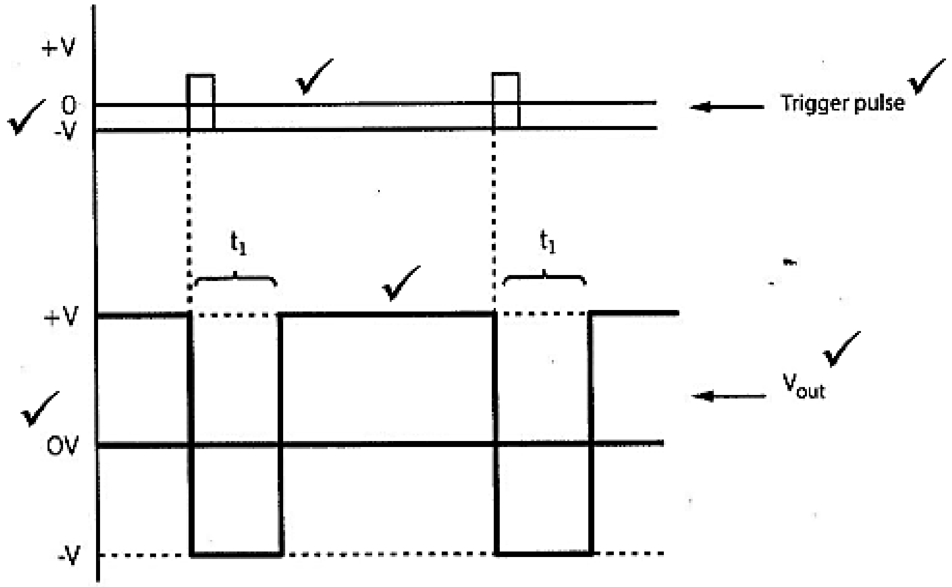
As in mathematical integration √
The circuit determines area by the gradient √ (4)

7.10 7.10.1 Bi-stable multi-vibrator √ (1)

7.10.2 contact bounce eliminator √
Relaxation oscillator √ (2)

7.11 7.11.1 A mono-stable multi-vibrator is a timing circuit that changes state once triggered, √ but returns to its original state after a certain time delay. √ (2)

7.11.2



(6)

7.12 7.12.1 RC phase shift oscillator (1)

7.12.2

$$f = \frac{1}{2\pi\sqrt{6RC}} \quad √$$

$$= \frac{1}{2\pi\sqrt{(10\times10^3) \times (250\times10^{-12})}} \quad √$$

$$= 41.09\text{Hz} \quad √$$

(3)
[50]

TOTAL: 200