Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2016

ELECTRICAL TECHNOLOGY MEMORANDUM

MARKS: 200

This memorandum consists of 10 pages.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY, TOOLS AND MEASURING INSTRUMENTS

1.1 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)

1.2
- Failure to wear protective clothing. ✓
- Horseplay in the workshop. ✓ (Any two relevant answers.) (2)

1.3 A badly planned/unorganised workshop. ✓ (Any relevant answer.) (1)

1.4
- To measure AC and DC voltage. ✓
- Analyse relationship between waveforms. ✓
- Measure the frequency of the waveforms. ✓ (3)

1.5
- 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)

[10]

QUESTION 2: SINGLE-PHASE AC GENERATION AND SINGLE-PHASE TRANSFORMERS

2.1
- 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)

2.2 Root-Mean-Square is the amount of DC that is required for producing the same heat as a AC waveform. ✓✓ (2)

2.3 $\Phi = BA$ ✓
$= 3 \times (900 \times 10^{-6})$ ✓
$= 2,7$ mWb ✓ (3)

2.4 $V_{AVE} = 0,637 \times V_{Max}$ ✓
$= 0,637 \times 16$ ✓
$= 10,19$ V ✓ (3)

2.5 $EMF = Blv\sin\theta$ ✓
$= 0,08 \times 0,3 \times 50 \sin 90^{o}$ ✓
$= 1,2$ V ✓ (3)

2.6 $V_{RMS} = V_{MAX} \times 0,707$

$V_{MAX} = \frac{V_{RMS}}{0,707}$ ✓

$= \frac{240}{0,707}$ ✓

$= 339,46$ V ✓ (3)

2.7
- RMS voltage is the DC voltage that will produce the same heat as equivalent AC voltage. ✓
- Average voltage is just an average value of voltage across a certain time of fluctuations of positive half cycle. ✓ Full wave average value is 0 volt. ✓ (3)

2.8 $V_{RMS} = V_{MAx} \times 0{,}707$ ✓
$= 75 \times 0{,}707$ ✓
$= 53{,}03\ V$ ✓

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

2.9 Lamination is done to reduce eddy current. ✓✓ (2)

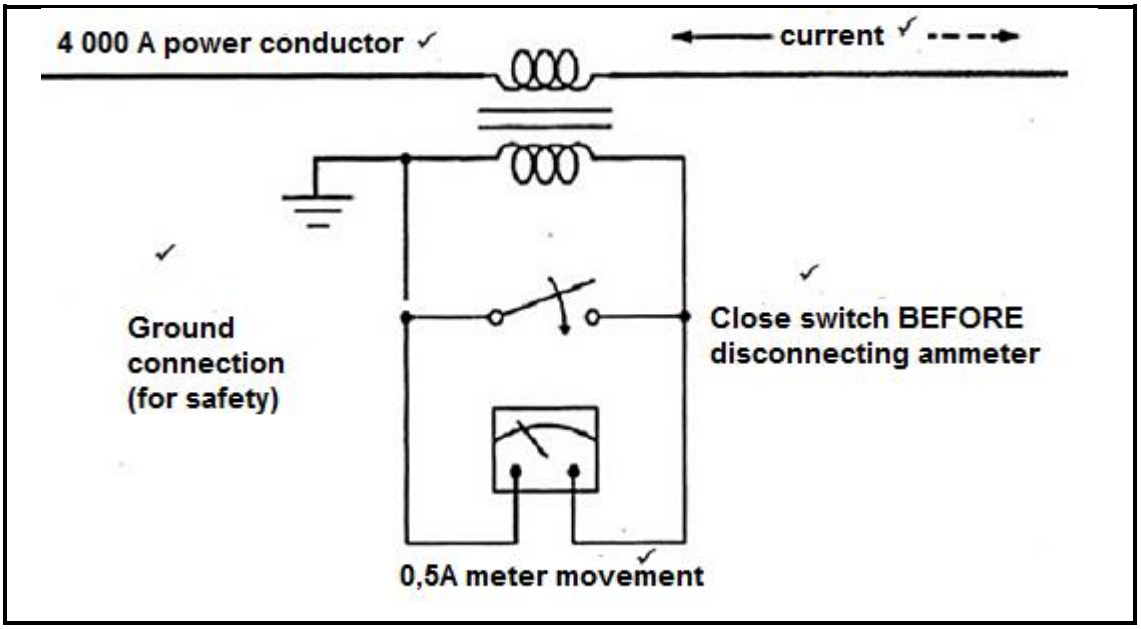
2.10 $F = \frac{p \times n}{60}$ ✓

$= \frac{2 \times 3\,600}{60}$ ✓

= 120 Hz ✓ (3)

2.11
- A transformer consists of two coils, a primary and a secondary which are supported by a core. ✓
- These coils are electrically separated. ✓
- The basic operation of transformer is based on mutual induction. ✓
- An AC voltage is applied across the primary windings. ✓
- A magnetic field build up and collapses in the primary coil. ✓
- This building up and collapses of the magnetic field in the primary coil cuts the secondary windings, induces an alternating voltage. ✓
- This induced secondary voltage can be more or less than the supply voltage. ✓ (Any 6 x 1) (6)

2.12



(5)

2.13 2.13.1 1. Fuse ✓
2. Potential Transformer (PT) ✓
3. Ground connection for safety ✓ (3)

2.14 Iron losses ✓
Copper losses ✓
Stray losses ✓ (Any three relevant answers) (3)

2.15
- Transmission and distribution over long distances. ✓
- High voltage direct current power transmission. ✓
- Low voltage direct current power sources. ✓
- Electrical furnaces in steel factories. ✓ (Any relevant answers) (3)

[50]

QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTIVE DEVICES

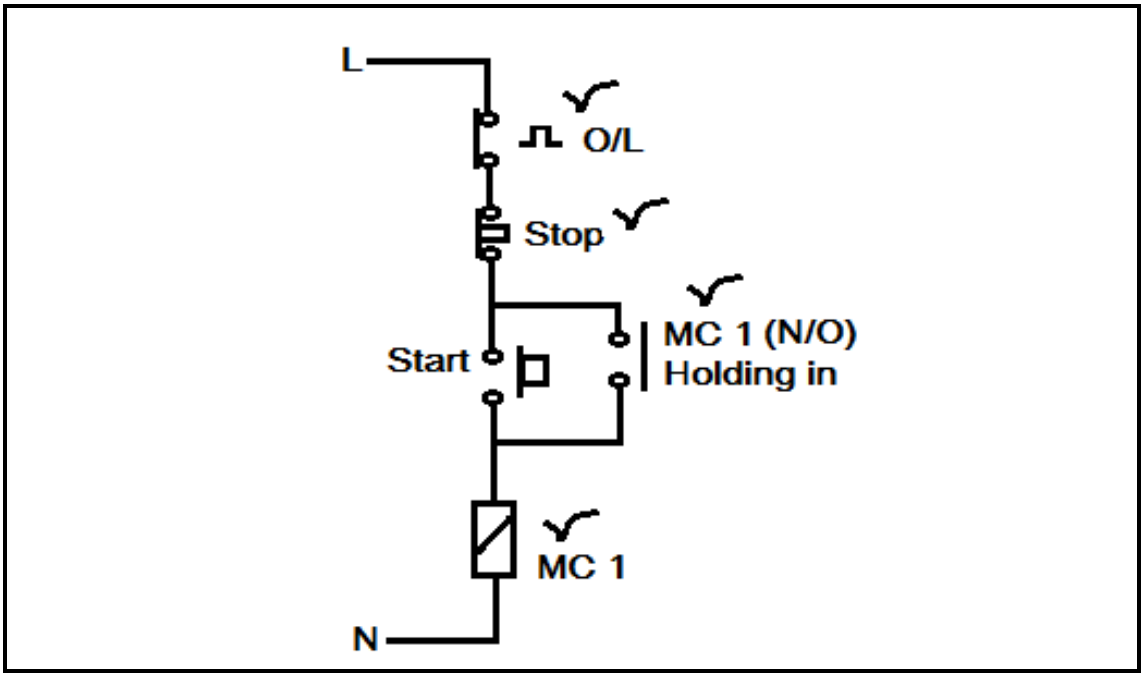
3.1 To automatically disconnect the supply in the event of an overload. ✓✓ (2)

3.2
- Bimetal strip ✓
- Electronic digital overload ✓
- Eutectic alloy ✓ (3)

3.3 To prevent the restarting of the motor after a power failure. ✓✓ (2)

3.4
- The bimetal strip is made up of two different metals bonded together. ✓
- The two metals have different thermal expansion characteristics. ✓
- The bimetal strip bends at a given rate when heated.
- In an overload condition, the heat generated by the heater will cause the bimetal strip to bend until the mechanism is tripped, stopping the motor. ✓ (4)

3.5



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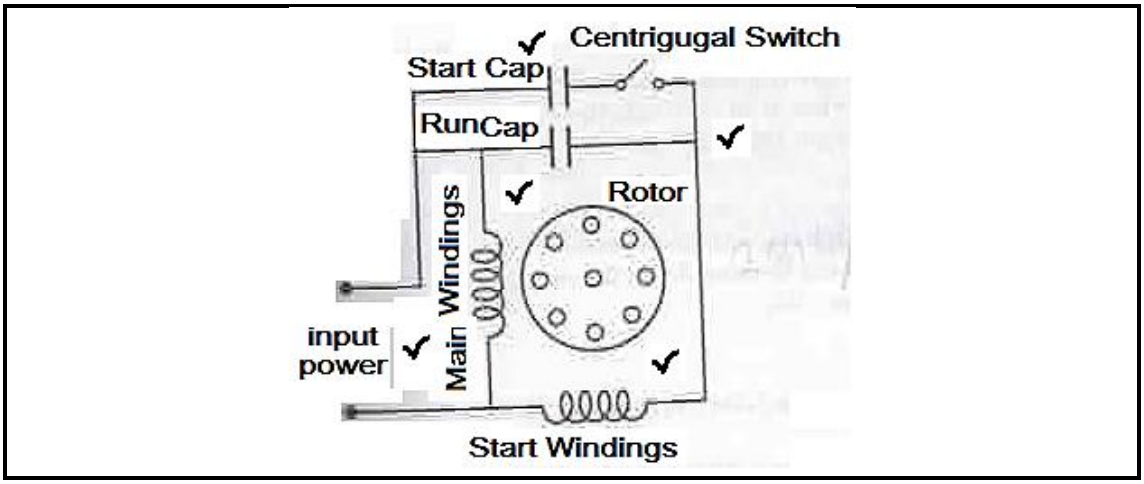
3.6
- Capacitor start motor ✓
- Universal motor ✓ (Any two relevant answers) (2)

3.7 To ensure that there are no leakage/ ✓short between the windings and earth. ✓ (6)

3.8



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3.9 By swapping the start windings ✓with respect to the main windings, but NOT both. ✓ (2)

3.10
- Mechanical test ✓
- Electrical test ✓ (2)

3.11
- Small grinders ✓
- Small fans ✓ (2)

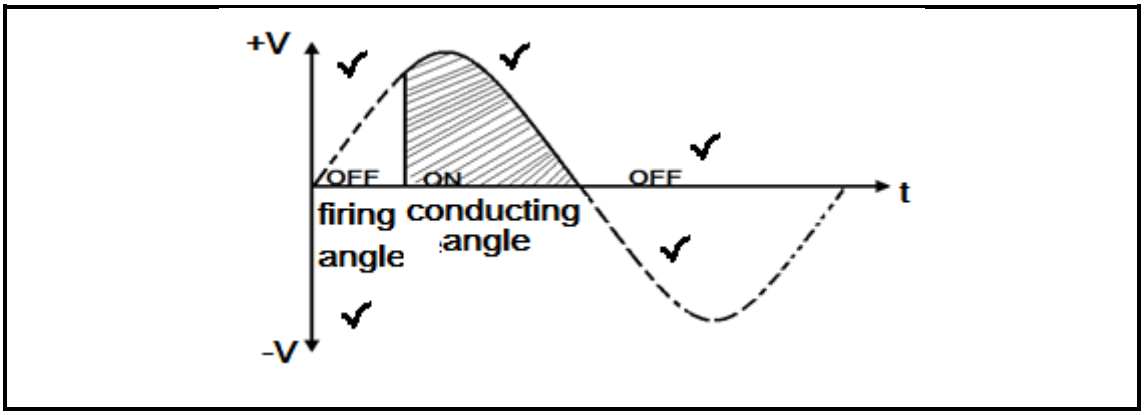
[30]

QUESTION 4: SEMI-CONDUCTOR DEVICES, POWER SUPPLIES, AND AMPLIFIERS

4.1
- Diode must be removed from the circuit before testing. ✓
- Diode should be tested in both directions and it should only give a reading in one direction and it is acceptable. ✓ (2)

4.2
- Cut-off ✓
- Active ✓
- Saturation ✓ (3)

4.3



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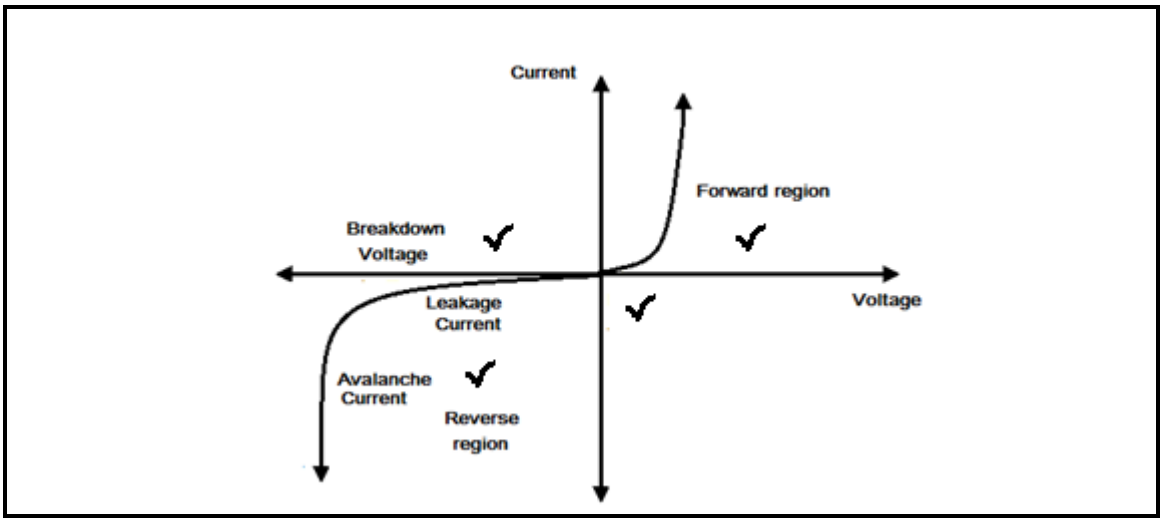
4.4



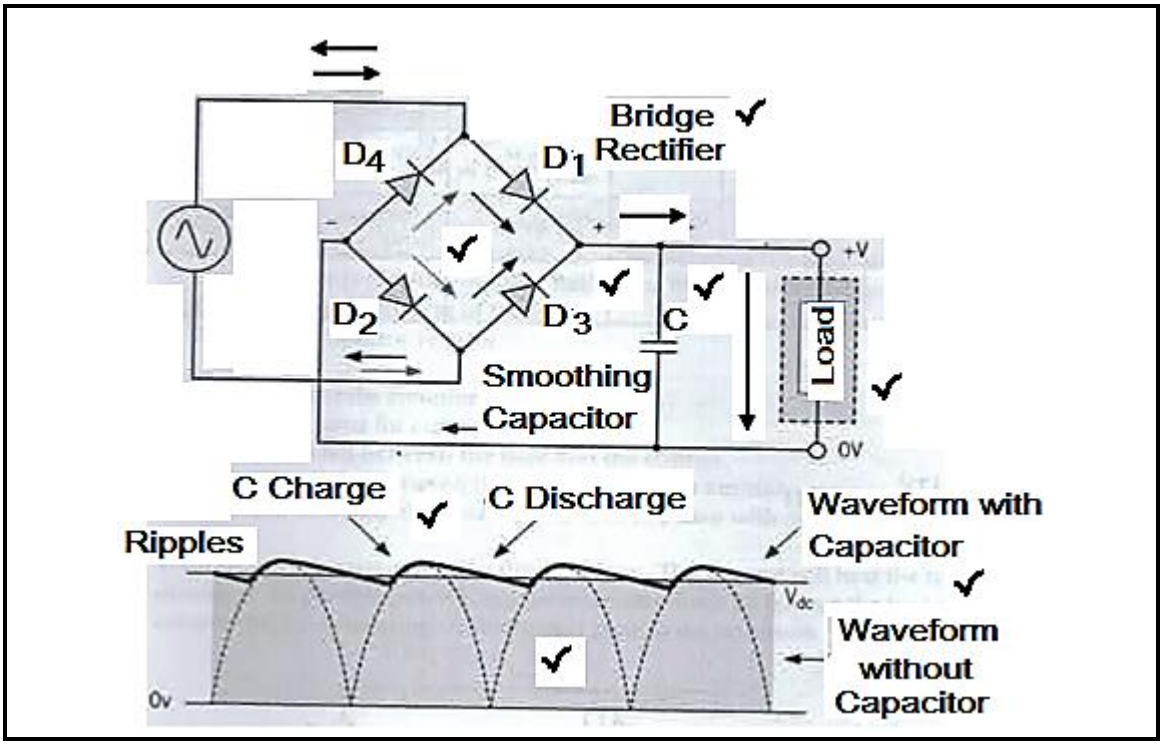
(4)

4.5 During the night:

1. The resistance of the LDR is high. ✓
2. Therefore V_{LDR} is high. ✓
3. But $V_{BE} = V_{LDR}$ so the $V_{BE} \geq 0{,}6$ V. ✓
4. Transistor will be switched on maximum. ✓
5. Maximum current flows through the LED and the transistor. ✓
6. The LED will be on. ✓ (6)

4.6 It needs a continually changing magnetic field to cut the windings and induce a current. ✓✓ (2)

4.7



(8)

4.8 4.8.1 12 V ✓ (1)

4.8.2 7,7 mA ✓ (1)

4.8.3 $Igain = \frac{\Delta Ic}{\Delta Ib}$ ✓

$= \frac{7,7\text{ mA} - 2\text{ mA}}{80\ \mu\text{A} - 20\ \mu\text{A}}$ ✓

= 95 ✓ (3)

4.8.4 80 µA ✓ (1)

4.9
- Common base ✓
- Common emitter ✓
- Common collector ✓ (3)

4.10 Negative feedback is when a portion of the output is fed back to the input, ✓ and the point at which the input and feedback signals meet there is a phase shift of 180^{o}. ✓ (2)

4.11
- Reduce noise and distortion at the output. ✓
- Enables us to design for a specific gain. ✓
- Stabilises voltage gain. ✓ (7)

4.12
- Class A ✓ – one transistor amplifies the entire input signal. ✓
- Class B ✓ – one transistor only amplifies half of the input signal i.e. only the positive half cycle. ✓
- Class AB✓ – This fits in between the class A and class B. More than 50% but less than 100% of the input signal is amplified. ✓
- Class C✓ – less than 50% of the input signal is amplified. ✓ (Any 3 x 1) (3)

[50]

QUESTION 5: RLC

5.1
- Current is maximum. ✓
- Impedance is minimum. ✓ (Any 2 x 1) (2)

5.2 Impedance is the total opposition a circuit consists of resistor, inductor and capacitor offers to the flow current. ✓✓ (2)

5.3 5.3.1 At resonant $X_L = X_C$

$X_L = 2\pi fL$ ✓

$= 2\pi$ x 50 x 0,0637 ✓

= 20,01 Ω ✓ (3)

5.2 5.3.2 Z = R

Z = 15 Ω ✓ (1)

5.4 5.4.1 $X_C = \frac{1}{2\pi fC}$

$= \frac{1}{2\pi \text{ x } 50 \text{ x } 220 \text{ x } 10^{-6}}$ ✓

= 14,47 Ω ✓

$X_L = 2\pi fL$

$= 2\pi$ x 50 x 75 x 10^{-3} ✓

= 23,56 Ω ✓

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{22^2 + (23{,}56 - 14{,}47)^2} = 23{,}8\ \Omega$ (4)

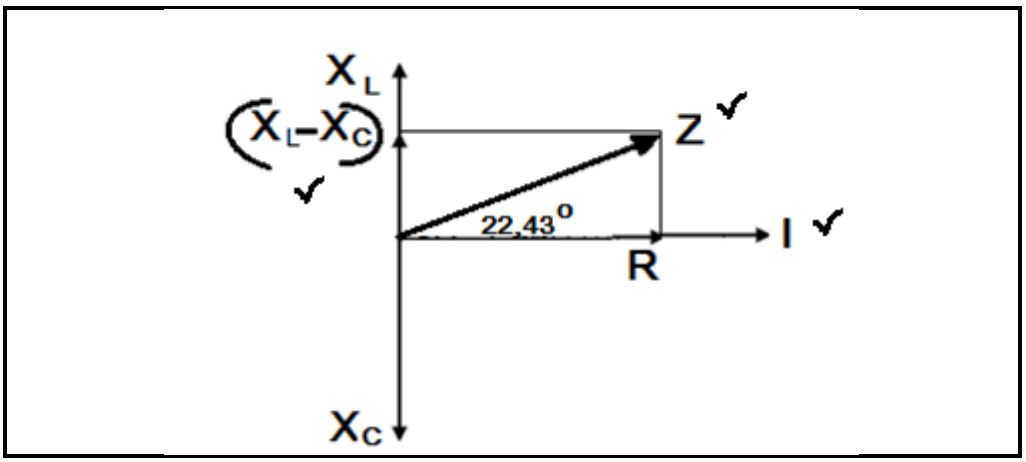
5.4.2 $\cos\theta = \frac{R}{Z}$

$\Theta = \cos^{-1} R/Z$ ✓

$= \cos^{-1}(22 / 23{,}8)$ ✓

$= 22{,}43^{O}$ lagging ✓ (3)

5.4.3



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QUESTION 6: LOGIC

6.1 The Product of Sum notation is where the Boolean expression is made up of a number of sum terms, separated by a product sign. ✓
Q= (A + B). (A + C). (B + C) ✓

The Sum of Product notation is where the Boolean expression is made up of a number of product terms, separated by a sum sign. ✓
Q = A.B + A.C + B.C ✓ (4)

6.2

A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

✓✓

$\overline{A}BC + A\overline{B}C + ABC + ABC = Q$

$B\overline{C}(A + \overline{A}) + A\overline{B}C + ABC = Q$ ✓

$BC + A\overline{B}C + ABC = Q$

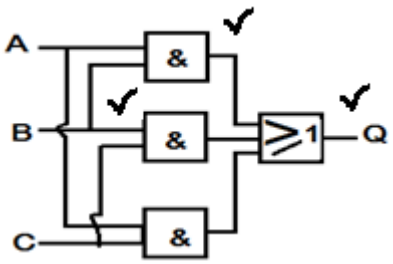
$C(B + A\overline{B}) + ABC = Q$ ✓

$C(B + \overline{A})B) + ABC = Q$

$BC + AC\overline{B} + ABC = Q$ ✓

$BC + A(\overline{C} + BC) = Q$

$BC + A(C + B) = Q$ ✓
$BC + AC + AB = Q$ ✓



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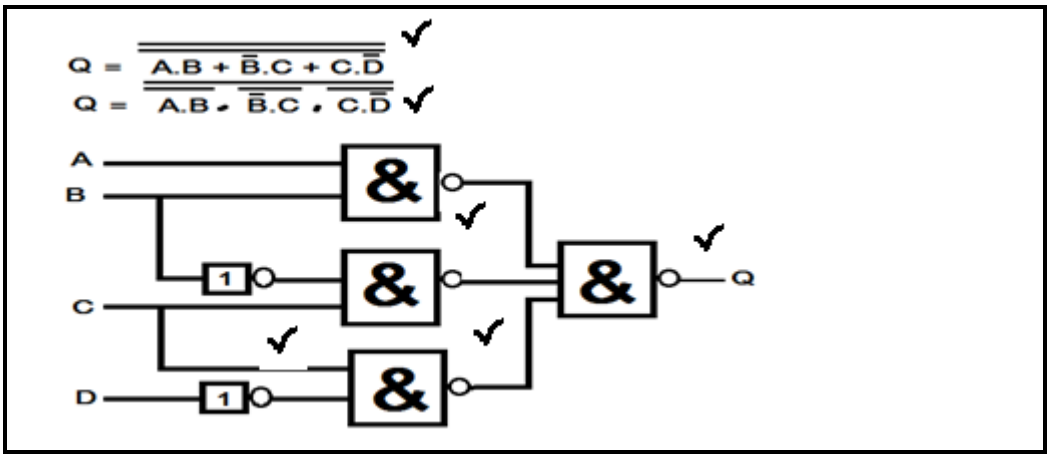
6.3 6.3.1



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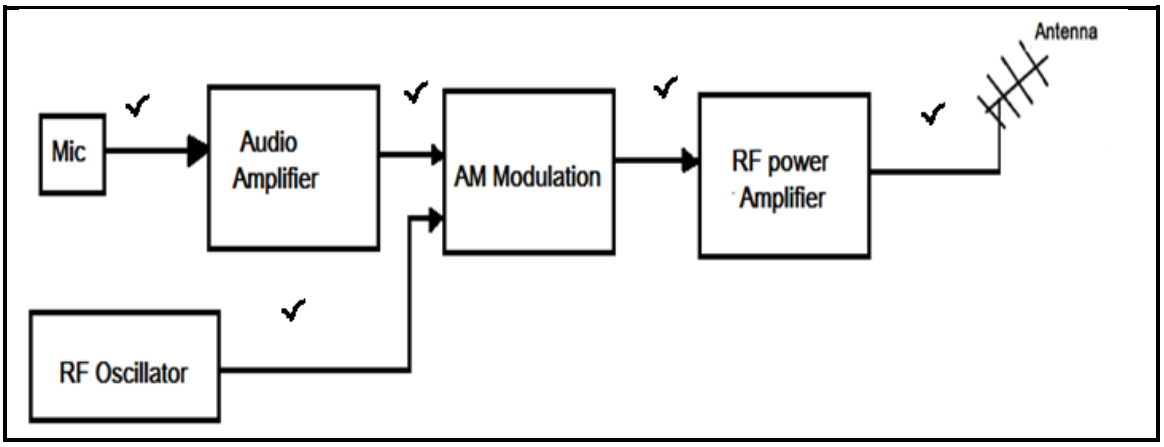
[20]

QUESTION 7: COMMUNICATIONS

7.1 7.1.1 1. Mixer ✓
2. Local oscillator ✓
3. AF amplifier ✓ (3)

7.1.2 FM receiver ✓ (1)

7.2



(5)

7.3 Foster-Seeley discriminators are sensitive to both frequency and amplitude variations, unlike some detectors. ✓ The discriminator compares the incoming FM signal against a reference signal ✓ and the difference between the two signals is the original audio signal. ✓ (3)

7.4 The main function is to connect transmitters and receivers to electromagnetic waves. ✓✓ (2)

7.5
- Its unsophisticated signal can be detected with simple equipment. ✓
- It uses a narrower bandwidth than FM. ✓ (2)

7.6
- Amplitude modulation ✓
- Frequency modulation ✓
- Pulse modulation ✓ (3)

[20]

TOTAL: 200