basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

ELECTRICAL TECHNOLOGY

EXEMPLAR 2017

MEMORANDUM

MARKS: 200

This memorandum consists of 22 pages and a 2-page formula sheet.

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 is used in a next calculation, the first answer will be deemed incorrect. However, should the incorrect answer be applied correctly, the marker has to re-calculate the answer using the incorrect values. If the candidate used the initial incorrect answer correctly thereafter, the candidate should receive the full marks for subsequent correct calculations.

3. This memorandum is only a guide with model answers. Alternative interpretations must be considered and marked on merit. This principle should be applied consistently by ALL teachers.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Regulations is a set of rules✓ that clarify or support the OHS act.✓ (2)

1.2 Information sign✓ (1)

1.3 No machine guards ✓
Poor lighting
Poor ventilation (1)

1.4 Ergonomics within the OHS Act deals with the issues of safe and effective interactions between the worker and the working environment;✓tools and equipment, materials, systems and tasks ✓ (2)
[6]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 Phase measurement✓
Frequency measurement✓
Voltage measurement (2)

2.2 The clamp meter is safer and easier to use✓ because there is no need to connect to the circuit to make measurements✓ (2)

2.3 To bend or deform lugs✓, ferrules and plugs in order to join them to wires✓
To clamp lugs and ferrules securely onto conductors (2)
[6]

QUESTION 3: DC MACHINES

3.1 A generator converts electrical energy to mechanical energy✓✓, while a motor converts mechanical energy to electrical energy. ✓✓In a generator, a shaft attached to the rotor is driven by a mechanical force and electric current is produced in the armature windings, while the shaft of a motor is driven by the magnetic forces developed between the armature and field. Current has to be supplied to the armature winding. (4)

3.2 Stator✓
Pole shoe✓
Field winding✓
Bearing
Shaft
Brush (3)

3.3 3.3.1 Its purpose is to carry current crossing the field✓, thus creating shaft torque in a rotating machine✓ or force in a linear machine and secondly to generate an electromotive force✓ (3)

3.3.2 Its purpose is to allow the current direction in the armature✓ to constantly change to maintain the correct magnetic field✓ which ensures motion of the armature.✓ (3)

3.4 Armature reaction is the effect of armature flux✓ on the main field which causes distortion of the main field. ✓ (2)

3.5 Resistance commutation✓ and
EMF commutation✓ (2)

3.6 3.6.1 Starting motor vehicle engines✓, driving cranes, trains, hoists, lifts, trolley buses and other electric vehicles. (1)

3.6.2 Steel rolling mills✓, guillotines, punch machines and shearing machines (1)

3.7 Copper losses✓,
magnetic losses✓ and
mechanical losses (2)

3.8

$$\eta = \frac{P_{out}}{P_{in}} \times 100 \quad ✓$$

✓

$$but\ P_{in} = VI$$

$$= 12 \times 0{,}125$$

$$= 1{,}5W \quad ✓$$

$$\eta = \frac{1.4}{1{,}5} \div 100 \quad ✓$$

$$= 93.33\% \quad ✓$$

(5)
[26]

QUESTION 4: SINGLE-PHASE AC GENERATION

4.1 Flux density refers to the amount of flux ✓lines in a given area and is measured in Weber per square✓ metre (Wb/m^2) or Tesla (T). (2)

4.2 Alternating current (AC) flows first in one direction, then in the opposite direction through the circuit✓ continually changing amplitude ✓. (When a signal's polarity changes, i.e. the signal switches between positive and negative, then this signal is an alternating current (AC) signal. AC voltage switches polarity back and forth.
Direct current flows in one direction only✓ at a constant value.✓ (4)

4.3 A conductor is placed inside a permanent magnetic field.✓
When it is rotated, the conductor will develop within itself a current according to Faraday's Law✓.
The closer the conductor moves to the pole, the greater the induced emf.✓
When the conductor moves past the pole, the induced voltage will decrease due to a decrease of the flux density. ✓
When the conductor moves to a point where it experiences the least amount of flux, the emf will be close to or equal to 0 V. ✓
When the conductor moves further, towards the opposite pole, the flux it experiences will cause an emf to develop in the opposite direction as that of the initial pole.
The process repeats until all motion is stopped.
The signal can be represented by the formula: $e = E_{\max} \sin\theta$ (5)

4.4
$$H = \frac{NI}{\ell} \quad ✓$$
$$= \frac{350 \times 200 \times 10^{-6}}{40 \times 10^{-6}} \quad ✓$$
$$= 1.75\, A/m \quad ✓$$
(3)

4.5
$$B = \frac{\Phi}{A} \quad ✓$$
$$= \frac{2,7 \times 10^{-3}}{9 \times 10^{-4}} \quad ✓$$
$$= 3T \quad ✓$$
(3)

4.6 4.6.1
$$f = number\, of\, revolutions\, per\, minute \quad ✓$$
$$= \frac{1400}{60} \quad ✓$$
$$= 23,33\, Hz \quad ✓$$
(3)

4.6.2
$$E_m = 2\pi BAnN \quad ✓$$
$$= 2\pi \times 0,5 \times 60 \times 10^{-4} \times 23.33 \times 150 \quad ✓$$
$$= 65,96V \quad ✓$$
(3)

4.6.3
$$e = E_m \sin\theta \quad ✓$$
$$= 65,96 \times \sin 68^\circ \quad ✓$$
$$61,13\, V \quad ✓$$
(3)
[26]

QUESTION 5: SINGLE-PHASE TRANSFORMERS

5.1 Core type ✓
Shell type ✓ (2)

5.2 5.2.1 Auto-transformer: To regulate transmission line voltages to the required value ✓**OR**
Used in low power applications to connect circuits with different voltage classes (1)

5.2.2 Centre tap transformer: Power supply rectifiers circuit. ✓ (1)

5.3 Lenz's law states that an induced electric current flows in a direction✓ such that the current opposes the change that induced it. ✓ (2)

5.4 The operation of the transformer is based on the principle of mutual induction (Faraday's law of mutual induction).
When an alternating voltage is applied to the primary winding, an alternating flux is set up in the core✓ which links with the secondary winding✓, inducing in it an emf of the same frequency✓. This is known as mutual inductance.
If a load is connected to the secondary winding, a current will flow through it✓.
Power is therefore transferred entirely magnetically from the primary✓ to secondary winding. ✓ (6)

5.5 Copper losses ✓
Iron losses ✓
Dielectric losses ✓
Stray losses (3)

5.6 5.6.1

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} \quad ✓$$

$$\frac{15}{1} = \frac{2200}{V_S} \quad ✓$$

$$V_S = 146.68\text{V} \quad ✓$$

(3)

5.6.2 Primary current

$$S = V_P \times I_P$$

$$I_P = \frac{S}{V_P} \quad ✓$$

$$= \frac{50000}{2200} \quad ✓$$

$$= 22.73\text{A} \quad ✓$$

(3)

5.6.3 Secondary current

$$\frac{N_P}{N_S} = \frac{I_S}{I_P} \quad ✓$$

$$\frac{15}{1} = \frac{I_S}{22.73} \quad ✓$$

$$I_S = 340.91\text{A} \quad ✓$$

(3)

[24]

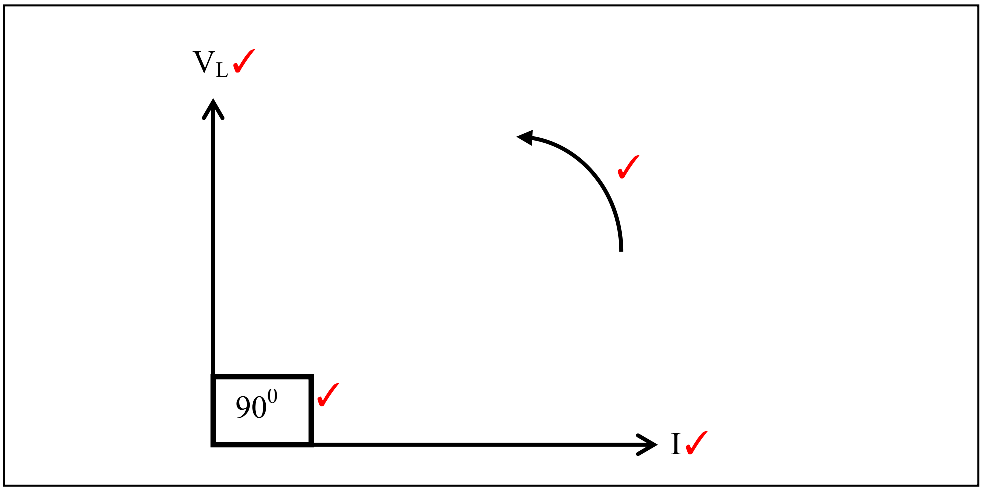
QUESTION 6: RLC CIRCUITS

6.1 6.1.1 Zero degrees (0°) ✓
(The voltage and current waveform are in phase with each other) (1)

6.1.2 Ninety degrees (90°) ✓
(The current leads the voltage waveform by a quarter of a cycle) (1)

6.2 6.2.1 When the frequency increases the inductive reactance will increase✓ and the current decreases ✓ (2)

6.2.2



(4)

6.3 6.3.1

$$X_L = 2\pi f L \checkmark$$
$$= 2 \times 3.142 \times 50 \times 47 \times 10^{-3} \checkmark$$
$$= 14.77\,\Omega \checkmark$$

(3)

6.3.2

$$Z = \sqrt{R^2 + X_L{}^2} \checkmark$$
$$= \sqrt{12^2 + 14.77^2} \checkmark$$
$$= 19.03\,\Omega \checkmark$$

(3)

6.3.3

$$I_S = \frac{V}{Z} \checkmark$$
$$= \frac{220}{19.03} \checkmark$$
$$= 11.56\text{ A} \checkmark$$

(3)

6.3.4

$$\text{Cos}\theta = \frac{R}{Z} \checkmark$$
$$= \frac{12}{19.03} \checkmark$$
$$\theta = 50.91^o \checkmark$$

(3)

6.3.5

$$P = V \times I \times \text{Cos}\,\theta \checkmark$$
$$= 220 \times 11.56 \times \text{Cos}50.91 \checkmark$$
$$= 1.603\text{ kW} \checkmark$$

or

$$P = I^2 \times R$$
$$= 11.56 \times 12$$
$$= 1.603\text{ kW}$$

(3)

6.3.6 The frequency change will not affect the value of the resistor.✓ (1)

[24]

QUESTION 7: CONTROL DEVICES

7.1 Electrical equipment/circuits are designed to operate at certain conditions/ratings✓and protection is provided to ensure that if the conditions/ratings are exceeded then the protection operates making the equipment/circuits safe.✓ (2)

7.2 7.2.1 In an electric power system overcurrent protection protects the load from excessive current✓ and excessive generation of heat and the risk of fire or damage to equipment.✓ (2)

7.2.2 The resettable overload allows for quick restoring of power after a fault condition✓ (1)

7.3 The function of no-volt protection is to prevent automatic re-starting✓ of a motor after a power failure✓ or in the case of a voltage drop that might be harmful to the motor.✓ In the case of an insufficient voltage supply the coil will not be able to retain the contacts and will automatically release them.✓ (4)

7.4 7.4.1 The function of the coil is to open✓ or close contacts on✓ the contactor.✓
(The coil when energised operates the contacts in the contactor.
These contacts will now open or close. This will lead to the control circuit operating and energising the power circuit which in turn supplies power to a load) (3)

7.4.2 The N/C stop contact is in series✓ with the control circuit so that when it is operated it breaks✓ the control circuit and power to the coil is broken. ✓ (3)

7.4.3 In parallel across the N/O start are N/O contacts on the main contactor.✓
As the contactor is energised the N/O contacts close. ✓
This maintains power to the coil once the N/O start is released.✓ (3)

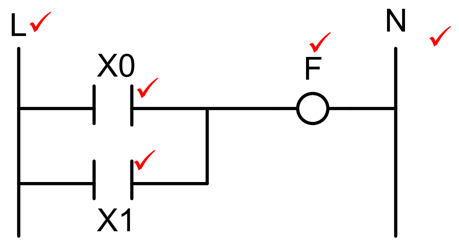
7.5 7.5.1 These are components that can be seen✓ and held.✓ (2)

7.5.2 A hard-wired system has physical wires that connect inputs and outputs to a central processing unit.✓
A soft-wired system is digital and does not contain any physical wires.✓
A hard-wired system will have a slower response.✓
A soft-wired system is usually much quicker.✓
A hard-wired system requires constant human intervention.
The soft wired system requires very little human intervention (4)

7.5.3 Switches✓
Sensors✓ (2)

7.5.4 A switch must be supplied which can terminate the power from all PLC equipment used if need to. ✓
A fuse or circuit breaker should be used to protect against overcurrent on the supply wiring.
Each input/output should have its own fuse for protection.
Anti-surge protection should also be fitted to stop any lightning surges from damaging any of the PLC equipment. (1)

7.6



(5)
[32]

QUESTION 8: SINGLE-PHASE MOTORS

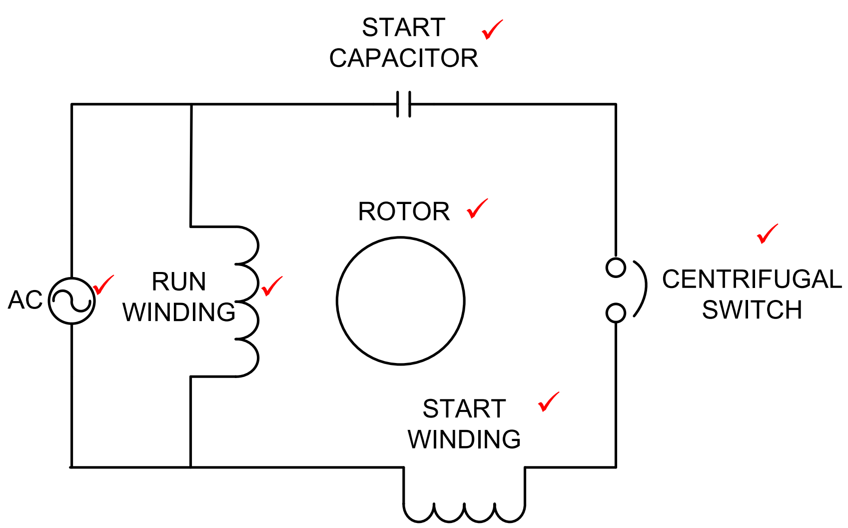
8.1 It can be connected✓ to both AC and DC✓ (2)

8.2 Synchronous AC motors operate at the same speed as the supply frequency.✓
Induction AC motors turn a little slower than the supply frequency due to slip. ✓ (2)

8.3 Capacitor-start motor ✓
Capacitor-start-and-run motor ✓ (2)

8.4 When the motor has reached a certain speed✓, the centrifugal switch opens✓, disconnecting the starting circuit from the supply✓ (3)

8.5



(6)

8.6 Check the mountings for cracks. ✓
Check the bearing ✓
Check the windings ✓ (3)

8.7 Used on conveyor belt drives✓
Power tools✓
Washing machines
Air conditioners and compressors (2)

8.8 It can be done by reversing✓ the connections of the starting winding or the running winding but not both.✓ (2)

8.9 As the load increases on the motor shaft, the actual speed of the rotor tends to fall further behind the speed of the rotating magnetic field in the stator. ✓
This difference in speed causes more magnetic lines to be cut, resulting in more torque being developed in the rotor and delivered to the shaft mechanical load. ✓
The rotor always turns at the exact speed necessary to produce the torque required to meet the load placed on the motor shaft at that moment in time.✓
This is usually a dynamic situation, with the motor shaft speed constantly changing slightly to accommodate minor variations in load. ✓ (4)

8.10 The torque of the split-phase motor is obtained from two stator windings. ✓
One winding has a higher impedance than the other✓, causing the single phase supply to split up to form an equivalent two-phase system. ✓
The fact that one stator winding is more inductive than the other causes a phase displacement of 90°✓ resulting in a rotating magnetic field which is required to rotate the rotor. ✓
The auxiliary winding is switched off by means of a centrifugal switch when the rotor has attained approximately 75% ✓of normal operating speed; it then runs as an ordinary induction motor.✓
The main object of the starting winding or auxiliary winding is to produce a two-phase system for self-starting. ✓ (6)
[32]

QUESTION 9: POWER SUPPLIES

9.1 9.1.1 Transformation steps-down the AC ✓voltage from 220 V to the required voltage✓ (2)

9.1.2 Rectification converts the AC signal✓ into a pulsating DC signal✓ (2)

9.2 9.2.1 The diode will be forward-biased because the anode is made more positive with respect to the cathode,✓ thereby reducing the depletion region✓ and allowing charge carriers to cross the junction resulting in conduction. ✓ (3)

9.2.2 The diode will be reverse-biased because the anode is made more negative with respect to the cathode,✓ thereby widening the depletion region✓ this will prevent majority charge carriers crossing the junction and the diode behaves like an insulator.✓ (3)

9.3 9.3.1 The series resistor limits the current that flows through the Zener protecting it. ✓
It also acts a voltage divider with the Zener setting the Zener voltage. (1)

9.3.2

$$P = V_Z \times I_Z \quad ✓$$

$$I_Z = \frac{P}{V_Z}$$

$$I_Z = \frac{2}{5} \quad ✓$$

$$= 400\ \text{mA} \quad ✓$$

(3)

9.3.3

$$R_S = \frac{V_S - V_Z}{I_Z} \quad ✓$$

$$R_S = \frac{12 - 5}{0.4} \quad ✓$$

$$= 17.5\ \Omega \quad ✓$$

(3)

9.3.4

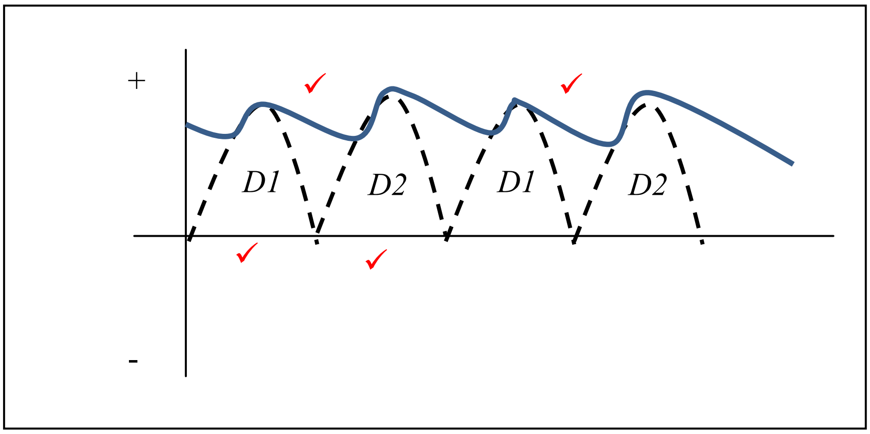
$$I_L = \frac{V_Z}{R_L} \quad ✓$$

$$I_L = \frac{5}{1000} \quad ✓$$

$$= 5\ \text{mA} \quad ✓$$

(3)

9.4



(4)
[24]

QUESTION 10: WAVEFORMS

10.1 Communication ✓
Broadcasting
Computer network
Radar navigation (1)

10.2 10.2.1 Sinusoidal wave✓ (1)
10.2.3 Triangular wave✓ (1)
10.2.4 Square wave✓ (1)
10.2.5 Saw tooth wave✓ (1)

10.3 The period is the time taken✓ to complete one full cycle✓ (2)

10.4 10.4.1 1. peak-to-peak value✓
2. peak value✓
3. instantaneous value✓
4. period✓ (4)

10.4.2 Maximum amplitude = 30 V✓ (1)

10.4.3 Time taken to complete one cycle. T = 20 ms✓ (1)

10.4.4 f = $^1/_T$✓
=1/20 ms✓
=50 Hz✓ (3)

10.4.5 $v = V_{max} \sin 2\pi ft"$ ✓
$= 30 \times \sin(2\pi \times 50 \times 0{,}008)$ ✓
$= 17{,}63\ V$ ✓ (3)

10.5 10.5.1 Clamper✓ (1)

10.5.2 The clamping circuit actually binds the upper or lower✓ extremes of a waveform to a fixed DC voltage level.✓
When unbiased, clamping circuits will fix✓ the voltage lower limit (✓or upper limit, in the case of negative clampers) to 0 volt. (4)
[26]

QUESTION 11: SEMICONDUCTORS

11.1 A semiconductor is a material of which the conductivity ✓lies between that of a conductor and an insulator.✓
Semiconductor devices are electronic components that are made from materials like silicon that have four valance electrons and their conduction can be controlled. (2)

11.2 11.2.1 Internet✓
Manufacturers' technical support material (1)

11.2.2 Semiconductors are very sensitive to temperature.✓ It is crucial to know the operating temperature of the device✓ so that it is not destroyed or its operating conditions changed.✓ (3)

11.2.3 Electrical characteristics✓
Equivalent values✓ (2)

11.3 Electron flow is the movement of electrons✓ through material, from a negative potential to a positive potential.✓
Conventional current flow is the flow of current✓ from a positive potential to a negative potential.✓ (4)

11.4 Solid-state devices are devices that are built entirely from solid materials✓ and in which the electrons or other charge carriers are confined entirely within the solid material.✓ (2)

11.5 N type material is formed when a semiconductor (silicon), which has four valence electrons✓, is doped with a material that has five valence electrons.✓
Four valance electrons from the semiconductor and from the impurity combine and form covalent bonds.✓
The fifth electron remains unbonded.✓
This creates an excess of electrons that can be broken away from their atoms and become part of conduction.✓ (5)

11.6 11.6.1 Positive✓ (1)

11.6.2 Negative✓ (1)

11.7 Voltage regulation ✓ (1)

11.8 Reverse bias mode ✓ (1)

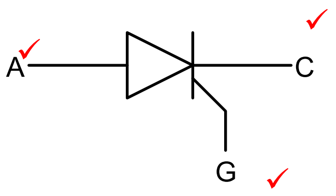
11.9 The emitter is connected to the negative pole of the battery.✓
The collector is connected to the positive pole of the battery.✓
When a positive voltage is connected to the base and it is sufficient in size to forward bias the base-emitter pn-junction (Si = 0,6 V and Ge = 0,3 V), a small base-emitter current will flow.✓
Electrons moves from the emitter to the lightly doped base.✓
These electrons come under strong attraction from the positive potential on the collector. ✓
A much larger collector-emitter current flows now. ✓
The small base emitter current✓ controls the much larger collector emitter current. ✓
General transistor equation: $I_{E=}I_B + I_C$ (8)

11.10 11.10.1 Output characteristic curve ✓ (1)

11.10.2 The Q point is determined by the DC biasing circuit of the transistor ✓ (1)

11.10.3 The position of Q point is selected according to the application of the transistor.
If transistor is to be used as switch✓, the Q point is in cut-off region for open switch and in saturation region for closed switch. ✓
If transistor is to be operated as amplifier, ✓Q point is placed exactly in the middle of the DC load line. ✓ (4)

11.11 11.11.1



(3)

11.11.2 Motor speed control ✓
Lamp dimming (1)

11.11.3 Holding current is the minimum current✓ that must flow to prevent the SCR from switching off.✓ (2)

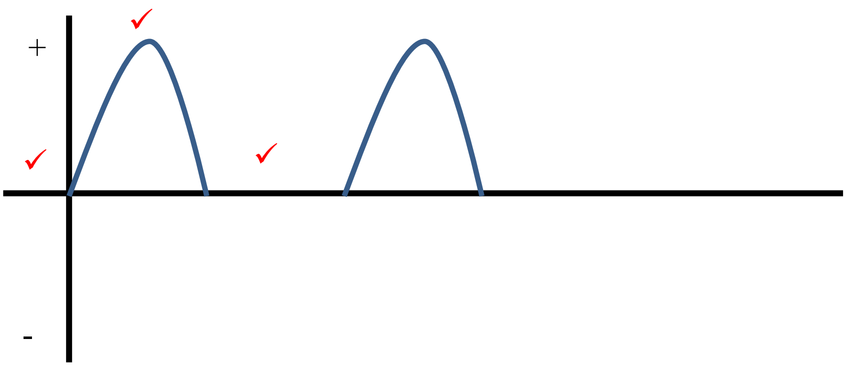
11.12 11.12.1 A TRIAC has full wave control compared to the SCR which has half wave control. ✓ (1)

11.12.2 Apply a voltage across the TRIAC in either polarity✓, then apply a pulse to the gate of either polarity. ✓
Apply a voltage across the TRIAC in either polarity and increase the voltage until V_{BO} is reached, then the TRIAC will switch on (2)

11.13 A DIAC is a bidirectional device✓ that switches on at a specific voltage and it does not have a gate. ✓ (2)
[48]

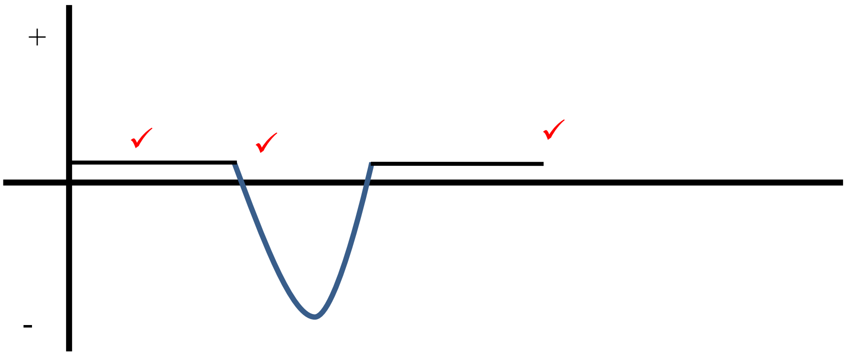
QUESTION 12: POWER SUPPLIES

12.1 12.1.1



(3)

12.1.2



(3)

12.2 12.2.1 The circuit is called a series-regulated power supply unit because the load resistor is connected in series with the transistor.✓ (1)

12.2.2 The Zener diode breaks down at a fixed voltage✓, therefore any increase in voltage at the input does not change the output.✓
The Zener is connected to the base of the transistor and keeps the base voltage V_{BE} constant✓ which then keeps the output voltage constant. ✓ (4)

12.3 12.3.1 $P = V_Z \times I_Z$ ✓

$$I_Z = \frac{P}{V_Z}$$

$$I_Z = \frac{2}{5}$$ ✓

$$= 400\,\text{mA}$$ ✓ (3)

12.3.2 $R_S = \dfrac{V_S - V_Z}{I_Z}$ ✓

$$I_Z = \frac{12 - 5}{0.4}$$ ✓

$$= 17.5\text{A}$$ ✓ (3)

12.3.3 $I_L = \dfrac{V_Z}{R_L}$ ✓

$$I_L = \frac{5}{1000}$$ ✓

$$= 5\,\text{mA}$$ ✓ (3)

[20]

QUESTION 13: AMPLIFIERS

13.1 An amplifier is an electronic device that increases✓ the power of a smaller input signal✓ (2)

13.2 Class A amplification occurs when the✓ transistor amplifies 360 degrees of the input waveform. The transistor is biased at the middle ✓of the load line, thus reducing the distortion to be at a minimum. ✓ (3)

13.3 Audio amplifiers✓ (1)

15.4 Biasing is used in amplifier design because it establishes the correct operating point✓ of the transistor amplifier ready to receive signals, thereby reducing any distortion✓ to the output signal. DC biasing refers to the application✓of the correct external voltages to establish an operating point on the characteristic output curve.✓ (4)

13.5 fixed-base biasing✓
voltage-divider biasing✓
collector-feedback biasing✓ (3)

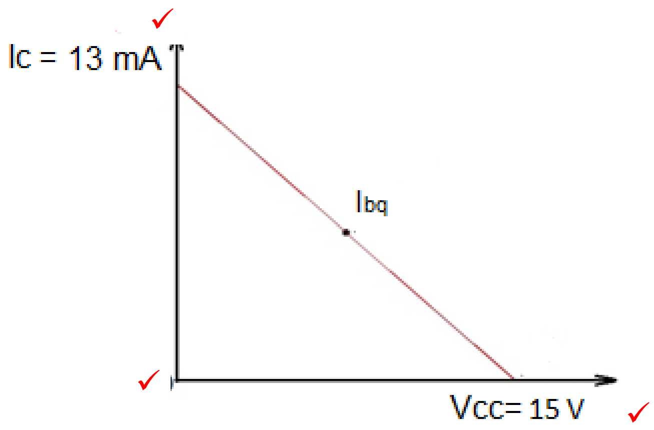
13.6 13.6.1 The purpose of the transistor in the circuit is to amplify the input signal. ✓✓✓ (3)

13.6.2 Resistors R_{b1} and R_{b2} act as a potential divider✓ that is able to hold the voltage on the base terminal ✓at a fixed value which will not vary under any conditions. ✓ (3)

13.6.3 The capacitor C_2 is a blocker ✓of the DC✓ component so that the output signal is not affected. (2)

13.6.4 $I_C = V_{CC}/(R_C + R_E)$
$= 15/(1000+100)$ ✓
$= 0{,}013\text{A}$✓
$= 13\text{ mA}$✓ (3)

13.7



(3)

13.8 The range of input frequencies amplified by the same factor (bandwidth) is increased✓
The amplifier is more stable to temperature changes. ✓ (2)

13.9 The gain of the amplifier can be increased ✓
The circuit will operate without an input signal✓ (2)
[32]

QUESTION 14: SENSORS AND TRANSDUCERS

14.1 14.1.1 A sensor is a detector or converter✓ of a measurable physical quantity to an electrical signal✓ that can be measured or read.✓ (3)

14.1.2 This is the internal generation of electrical charge✓ as a result of an externally applied mechanical force like pressure.✓ (2)

14.2 The dynamic microphone has a small movable induction coil attached to a diaphragm placed in a magnetic field created by a permanent magnet.✓
The sound waves from a voice create air pressure variations that make the diaphragm vibrate. ✓
The vibrating diaphragm attached to the coil produces an induced varying current. ✓
In this way sound energy will be converted to electrical energy. ✓ (4)

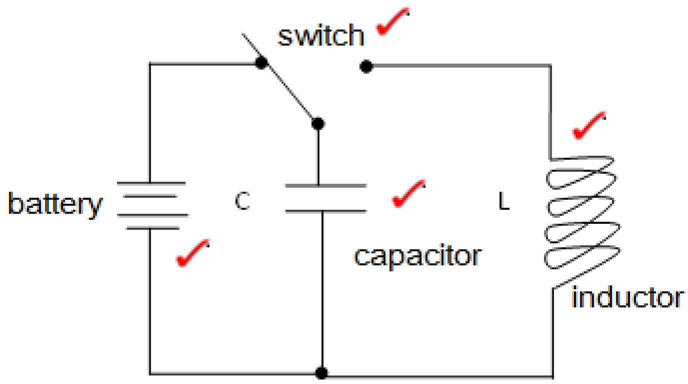
14.3 With a PTC thermistor, the resistance increases with increasing temperature.✓ (1)

14.4 Thermistors are used as temperature sensors for self-regulating heating elements. ✓
For self-resetting overcurrent protectors (1)

14.5 The gas or humidity sensors are used to detect the presence of:
Toxic gases ✓
Flammable gases
Oxygen depletion levels
Alcohol levels in breathalyzers
Humidity levels in the air (1)
[12]

QUESTION 15: COMMUNICATION SYSTEMS

15.1



(4)

15.2 The role of an oscillator is to generate a sinusoidal wave✓ at constant amplitude and constant frequency.✓ (2)

15.3 It is the frequency at which systems will oscillate✓ in the absence of damping ✓or driving forces ✓
The natural frequency of a system is the frequency at which the system "likes" to oscillate at. (3)

15.4 Positive feedback is used in oscillators✓ to start the oscillation and to keep them running or oscillating. ✓ (2)

15.5 Modulation is the process by which a carrier wave✓ is altered in such a way that it is able to carry✓ information on it✓ (3)

15.6 Amplitude modulation✓
Frequency modulation✓
Pulse modulation ✓ (3)

15.7 15.7.1 Tuned circuits are used to discriminate✓ between the different frequencies✓ and only pass the desired frequency to the next stage✓. The circuit will resonate at the desired frequency and reject all other frequencies. (3)

15.7.2 RF amplifiers amplify the frequency selected by the tuned✓ circuit to a usable magnitude. ✓ (2)

15.7.3 The intelligence is removed from the carrier wave ✓and the RF carrier is filtered to ground. ✓Thus only the desired audio signal remains✓. Diode detection, using capacitors and resistors, is commonly used in detection circuits.
It detects the presence or absence of the radio signal to produce clicks in the receiver's earphones representing the Morse code symbols (3)

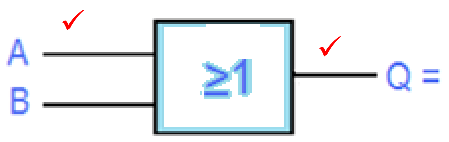
15.7.4 The AF amplifier is used to amplify audio intelligence✓ to a value sufficient to drive the loud speaker✓. (2)

[26]

QUESTION 16: LOGICS

16.1 16.1.1 OR function✓ (1)

16.1.2



(2)

16.1.3 Q✓ =A+B✓ (2)

16.1.4

TRUTH TABLE

B	A	OUT
0	0	0 ✓
0	1	1 ✓
1	0	1 ✓
1	1	1 ✓

(4)

16.2 16.2.1 Q1✓= AB✓ (2)

16.2.2 Q2✓= AC✓ (2)

16.2.3 Q= AB✓+✓ AC✓ (3)

16.3

$$X = \bar{A}B\bar{C} + AB\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$$

$$= (\bar{A}B\bar{C} + AB\bar{C}) \checkmark + (A\bar{B}\bar{C} \checkmark + \bar{A}\bar{B}\bar{C})$$

$$= B\bar{C}(\bar{A} + A) \checkmark + \bar{B}\bar{C}(A \checkmark + \bar{A})$$

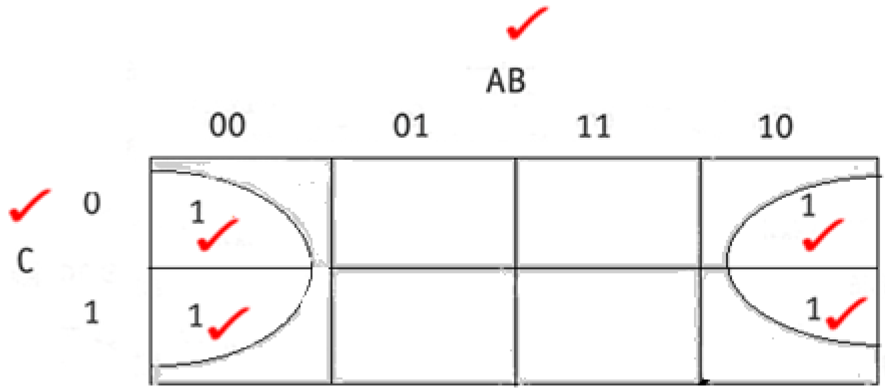
$$= B\bar{C} + \bar{B}\bar{C} \checkmark$$

$$= \bar{C}(B + \bar{B}) \checkmark$$

$$= \bar{C} \checkmark$$

(7)

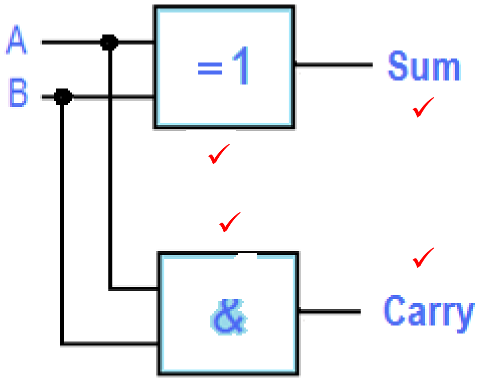
16.4



$X = \bar{B}$ ✓

(7)

16.5



(4)

16.6 Logic high✓
Logic low✓ (2)

16.7 Simple, compatible with CMOS if the applied voltage is the same, can be constructed using discrete components. ✓
They have a low current drain✓ (2)

16.8 Slow switching speed✓
They can be easily destroyed by static electricity✓ (2)

QUESTION 17: POWER SUPPLIES

17.1 Power supply can convert an alternating current to required value of direct current✓ for use in radios, cellphones and computers. ✓ (2)

17.2 17.2.1 The circuit is called a series-regulated power supply unit because the load resistor is connected in series with the transistor. ✓ (1)

17.2.2 The Zener diode breaks down at a fixed voltage✓ therefore any increase in voltage at the input does not change the output. ✓ The Zener is connected to the base of the transistor and keeps the base voltage V_{BE} constant✓ which then keeps the output voltage constant. ✓ (4)

17.3 Has a very 'clean' output with little noise introduced into the DC output. ✓
Is simple. ✓
Is cheap. (2)

17.4 Personal computers ✓
Battery chargers ✓
Central power distribution
Vehicles
Consumer electronics, e.g. TVs
Lighting, e.g. LEDs
Space stations (2)
[12]

TOTAL: 200

FORMULA SHEET

Single-phase AC Generation

Magnetic field strength

$$H = \frac{N \times I}{l}\left(A/m\right)$$

Flux density

$$\beta = \frac{\varphi}{A}(\text{Tesla})$$

Pole pairs

$$p = \frac{\text{number of poles}}{2}$$

Area of the coil

$$A = lb\left(m^2\right)$$

Frequency of rotation

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

$$f = p \times n$$

Instantaneous value

$$\omega = 2\pi f(\text{radians})$$

$$\theta = \omega\, t(\text{degrees})$$

$$i = I_{max} \times \text{Sin}\theta\,(V)$$

$$v = V_{max} \times \text{Sin}\theta\,(V)$$

Maximum value

$$V_{max} = V_{RMS} \times 1.414\,(V)$$

$$V_{max} = 2\pi\beta AnN(V)$$

$$E = \beta lv(V)$$

RMS value

$$V_{RMS} = V_{max} \times 0.707\,(V)$$

Single-phase Transformer

Power

$$P = VL\text{Cos}\theta(\text{Watt})$$

$$S = VL\,(VA)$$

$$Pr = VL\text{Sin}\theta(\text{Watt})$$

Ration calculation

$$\frac{V_p}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_P}$$

$$\eta = \frac{Po}{Pin} \times 100\%$$

RLC circuits

Inductive reactance

$$X_L = 2\pi fL(\Omega)$$

Capacitive reactance

$$X_C = \frac{1}{2\pi fC}(\Omega)$$

Impedance

$$Z = \sqrt{R^2 + (X - X)^2}\,\Omega$$

Power

$$P = VI\,\text{Cos}\theta\,(\text{Watt})$$

Power factor

$$\text{Cos}\theta = \frac{R}{Z}$$

$$\text{Cos}\theta = \frac{V_R}{V_Z}$$

Phase angle

$$\theta = \text{Cos}^{-1}\ \frac{R}{Z}(\text{deg})$$

$$\theta = \text{Cos}^{-1}\ \frac{V_R}{V_Z}(\text{deg})$$

Average value $V_{Average} = V_{max} \times 0.637\,(V)$	Resonance frequency $f_r = \frac{1}{2\pi\sqrt{LC}}\,(\text{Hertz})$ Q factor $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ $q = \frac{1}{R}\sqrt{\frac{L}{C}}$ $q = \frac{X_C}{R}$
Control devices $I_{op} = I_{max} \times 125\%\,(\text{Ampere})$	
Power supply $P = V_Z \times I_Z$ $R_S = \frac{V_S - V_Z}{I_Z}$ $I_L = \frac{V_Z}{R_L}$	
Amplifiers $I_C = \frac{V_{CC}}{R_C + R_E}$	**Bandwidth** $BW = \frac{f_r}{q}\,(Hertz)$ $l =$