EKURHULENI TECH

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PAST EXAM PAPER & MEMO N2

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REPUBLIC OF SOUTH AFRICA

T630**(E)**(N18)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

INDUSTRIAL ELECTRONICS N2

(8080602)

18 November 2016 (X-Paper)
09:00–12:00

Nonprogrammable scientific calculators and drawing instruments may be used.

This question paper consists of 6 pages and 1 formula sheet of 2 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL ELECTRONICS N2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. Number the answers according to the numbering system used in this question paper.

4. Clearly show ALL calculations, diagrams, and graphs which you have used in determining the answers.

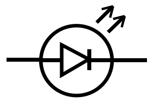
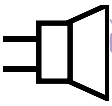
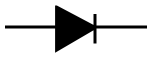
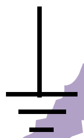
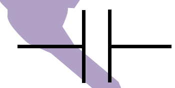
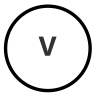
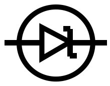
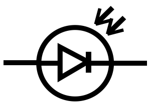
5. All diagrams and sketches must be neat and labelled.

6. If necessary, answers should be rounded off to THREE decimal places, unless stated otherwise.

7. Write neatly and legibly.

QUESTION 1

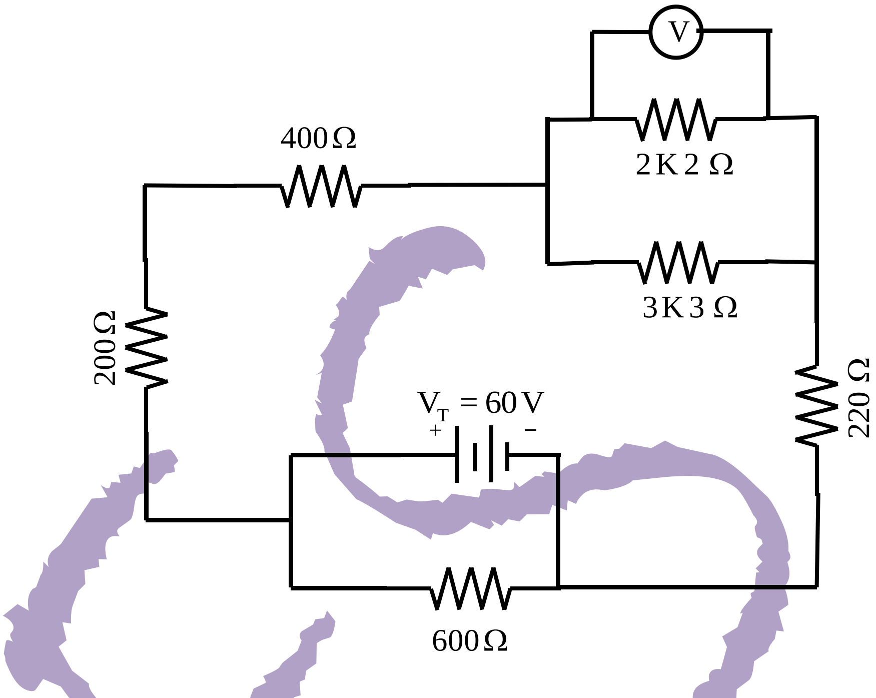
1.1 Choose an/a item/word from COLUMN B that matches an/a item/symbol in COLUMN A. Write only the letter (A–J) next to the question number (1.1.1–1.1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1		A	zener diode
1.1.2		B	light-emitting diode
1.1.3		C	voltmeter
1.1.4		D	capacitor
1.1.5		E	battery
1.1.6		F	loudspeaker
1.1.7		G	switch
1.1.8		H	diode
1.1.9		I	photodiode
1.1.10		J	ground/earth

(10 × 1) **[10]**

QUESTION 2

The DC circuit below has a supply voltage of 60 V. A voltmeter is connected across the 2K2 Ω resistor.



Analyse the circuit and calculate the following:

2.1 The total resistance of the circuit (6)

2.2 The total current flowing in the circuit (2)

2.3 The voltage across the 2K2 Ω resistor (4)
[12]

QUESTION 3

A 20 Ω resistor , 200 μF capacitor and a 20 mH inductor are connected in series. The circuit is connected to a 100 V / 50 Hz supply.
Calculate the following:

3.1 The capacitive reactance (2)

3.2 The inductive reactance (2)

3.3 The impedance of the circuit (2)

3.4 The current flowing in the circuit (2)

3.5 The phase angle between the voltage and the current (2)

3.6 The voltage across the coil (3)

3.7 The resonant frequency (2)
[15]

QUESTION 4

The equation for a certain alternating wave is given by the formula:

$$e = 200 \sin(31{,}41\, t)\ V$$

Use the formula to calculate the following :

4.1 The maximum or the peak value of the voltage (2)

4.2 The average and the RMS values (2)

4.3 The form and the crest factors (2)

4.4 The frequency of the wave (2)

4.5 The instantaneous value of the voltage 6 milliseconds after zero (2)
[10]

QUESTION 5

5.1 With the aid of a neat circuit diagram, explain the concept of f*orward bias* as applicable to PN-junction diodes. (4)

5.2 Draw a labelled circuit diagram of a half-wave rectifier using a step-down transformer, a diode, a capacitor and a load resistor. The input and output waveforms must be shown. (6)
[10]

QUESTION 6

6.1 State TWO advantages of digital meters over analogue meters. (2)

6.2 An ammeter has a full-scale deflection current of 3 mA and an internal resistance of 50 Ω.

Calculate the following:

6.2.1 The shunt resistance to extend the meter range to 30 mA. (4)

6.2.2 The voltage to produce a full-scale reading for the basic meter movement. (2)

6.2.3 The multiplier resistor extending the full-scale meter reading to 12 V. (4)
[12]

QUESTION 7

7.1 Draw and label a single-stage NPN transistor amplifier in a common emitter configuration showing both the input and output waveforms. (6)

7.2 Name the THREE classes of amplifiers. (3)
[9]

QUESTION 8

8.1 Define *Lenz's law*. (3)

8.2 State TWO advantages of a synchro-system over a mechanical system. (2)

8.3 Draw a neat sketch showing the coupling between a transmitter and a receiver to give a 180^0 phase shift. (5)
[10]

QUESTION 9

9.1 Explain the operation of the following transducers:

9.1.1 Thermocouple

9.1.2 Bimetal strip

(2 × 3) (6)

9.2 Calculate the gain of an amplifier that produces a voltage of 12 V over a 20 Ω loudspeaker when a current of 14 mA is applied to the input.

The input impedance is 15 KΩ. (6)
[12]

TOTAL: 100

INDUSTIAL ELECTRONICS N2: FORMULA SHEET

DC THEORY

$$V = I \times R$$

$$R_T = R_1 + R_2$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$P = V \times I$$

$$P = I^2 \times R$$

$$P = \frac{V^2}{R}$$

MEASURING INSTRUMENTS

$$R_{SH} = \frac{I_M \times R_M}{I_{SH}}$$

$$R_S = \frac{V_T}{I_M} - R_M$$

TRANSISTORS

$$I_e = I_c + I_b$$

DECIBEL RATIOS

$$N = 10\log\frac{P_{out}}{P_{in}}$$

$$N = 20\log\frac{I_{out}}{I_{in}} + 10\log\frac{R_{out}}{R_{in}}$$

$$N = 20\log\frac{V_{out}}{V_{in}} + 10\log\frac{R_{in}}{R_{out}}$$

If $R_{in} = R_{out}$

then $N = 20\log\frac{I_{out}}{I_{in}}$

and $N = 20\log\frac{V_{out}}{V_{in}}$

RESISTANCE

$$R = \frac{\rho l}{A}$$

$$A = \frac{\pi d^2}{4}$$

AC THEORY

$$t = \frac{1}{f}$$

$$e = E_m \sin 2\pi f t$$

$$i = I_m \sin 2\pi f t$$

$$\theta = 2\pi f t$$

$$I_{AVE} = \frac{I_1 + I_2 + I_3}{n}$$

$$I_{RMS} = \sqrt{\frac{I_1^2 + I_2^2 + I_3^2}{n}}$$

$$V_{AVE} = \frac{V_1 + V_2 + V_3}{n}$$

$$V_{RMS} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2}{n}}$$

$$V_{AVE} = V_M \times 0{,}637$$

$$V_{RMS} = V_M \times 0{,}707$$

$$\text{Form factor} = \frac{RMS \text{ value}}{AVE \text{ value}}$$

$$\text{Crest factor} = \frac{\text{Maximum value}}{RMS \text{ value}}$$

$$\omega = 2\pi f$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

$$V_T = \sqrt{V_R^2 + V_L^2}$$

$$V_T = \sqrt{V_R^2 + V_C^2}$$

$$V_T = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{R^2 + X_L^2}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$I_T = \frac{V_T}{Z}$$

$$V_C = I_T \times X_C$$

$$V_R = I_T \times R$$

$$V_L = I_T \times X_L$$

$$\theta = \cos^{-1} \frac{R}{Z}$$

$$f_O = \frac{1}{2\pi\sqrt{LC}}$$

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MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

INDUSTRIAL ELECTRONICS N2

18 NOVEMBER 2016

This marking guideline consists of 7 pages.

✓ = 1 MARK √ = ½ MARK

QUESTION 1

1.1	1.1.1	B
	1.1.2	E
	1.1.3	F
	1.1.4	H
	1.1.5	J
	1.1.6	D
	1.1.7	C
	1.1.8	A
	1.1.9	I
	1.1.10	G

(10 × 1) **[10]**

QUESTION 2

2.1

$$R_{P_1} = \frac{2200 \times 3300}{2200 + 3300} \checkmark$$

$$= 1320\,\Omega \checkmark$$

$$R_{S_1} = 200 + 400 + 1320 + 220 \checkmark$$

$$= 2140\,\Omega \checkmark$$

$$R_T = \frac{2140 \times 600}{2140 + 600} \checkmark$$

$$= 468,6\,\Omega \checkmark$$

(6)

2.2

$$I_T = \frac{V_T}{R_T}$$

$$= \frac{60}{468,6} \checkmark$$

$$= 0,128\,\text{A} \checkmark$$

(2)

2.3

$$V_{600\Omega} = 60\,\text{V}$$

$$I_{600\Omega} = \frac{V_{600\Omega}}{R}$$

$$= \frac{60}{600} \surd$$

$$= 0,1\,\text{A} \checkmark$$

$$\text{I}_{P_1} = 0,128 - 0,1 = 0,028\,\text{A} \surd$$

$$\text{V}_{2K2\Omega} = I_{P_1} \times R_{P_1}$$

$$= 0,028 \times 1320 \checkmark$$

$$= 36,96\,\text{V} \checkmark$$

(4)
[12]

QUESTION 3

3.1
$$X_C = \frac{1}{2\pi f C}$$
$$= \frac{1}{2\pi \times 50 \times 200 \times 10^{-6}} \checkmark$$
$$= 15,915\,\Omega \checkmark$$
(2)

3.2
$$X_L = 2\pi f L$$
$$= 2\pi \times 50 \times 20 \times 10^{-3} \checkmark$$
$$= 6,283\,\Omega \checkmark$$
(2)

3.3
$$Z = \sqrt{R^2 + (X_C \square X_L)^2}$$
$$= \sqrt{20^2 + (15,915 - 6,283)^2} \checkmark$$
$$= 22,199\,\Omega \checkmark$$
(2)

3.4
$$I_T = \frac{V_T}{Z}$$
$$= \frac{100}{22,199} \checkmark$$
$$= 4,505\,\text{A} \checkmark$$
(2)

3.5
$$\theta = \cos^{-1}\frac{R}{Z}$$
$$= \cos^{-1}\frac{20}{22,199} \checkmark$$
$$= 25,718^\circ \checkmark$$
(2)

3.6
$$V_R = I \times R = 4,505 \times 20 = 90,1\,\text{V} \checkmark$$
$$V_L = I \times X_L = 4,505 \times 6,283 = 28,305\,\text{V} \checkmark$$
$$V_T = \sqrt{V_R{}^2 + V_L{}^2}$$
$$= \sqrt{90,1^2 + 28,305^2} \surd$$
$$= 94,441\,\text{V} \surd$$

or V_L =I x X_L = 4,505x6,283= 28,305V

(3)

3.7
$$f_O = \frac{1}{2\pi\sqrt{LC}}$$
$$= \frac{1}{2\pi\sqrt{20 \times 10^{-3} \times 200 \times 10^{-6}}} \checkmark$$
$$= 79,577\,\text{Hz} \checkmark$$
(2)
[15]

QUESTION 4

4.1 $V_{max} = 200\ V$ (2)

4.2 $V_{AVE} = 0,637 \times 200 \surd = 127,4\ V\ \surd$

$V_{RMS} = 0,707 \times 200 \surd = 141,4\ V\ \surd$ (2)

4.3 $\text{Form factor} = \dfrac{RMS\ \text{value}}{AVE\ \text{value}} = \dfrac{141,4}{127,4} \surd = 1,11 \surd$

$\text{Crest factor} = \dfrac{\text{Maximum value}}{RMS\ \text{value}} = \dfrac{200}{141,4} \surd = 1,414\ \surd$ (2)

4.4 $\omega = 2\pi f$

$f = \dfrac{\omega}{2\pi}$

$= \dfrac{31,41}{2\pi}$ ✓

$= 5\ \text{Hz}$ ✓ (2)

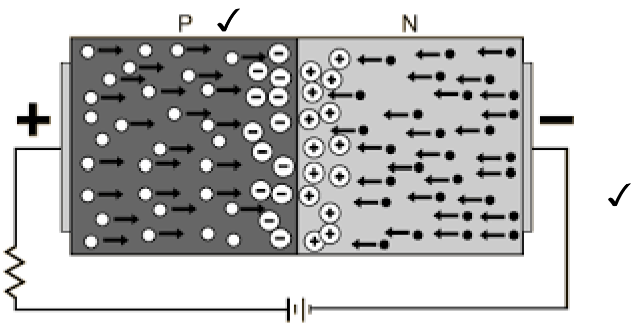
4.5 $e = 200 \sin 31,41 \times 6 \times 10^{-3} \times \dfrac{180}{\pi}$ ✓

$= 35,832\ V$ ✓ (2)

[10]

QUESTION 5

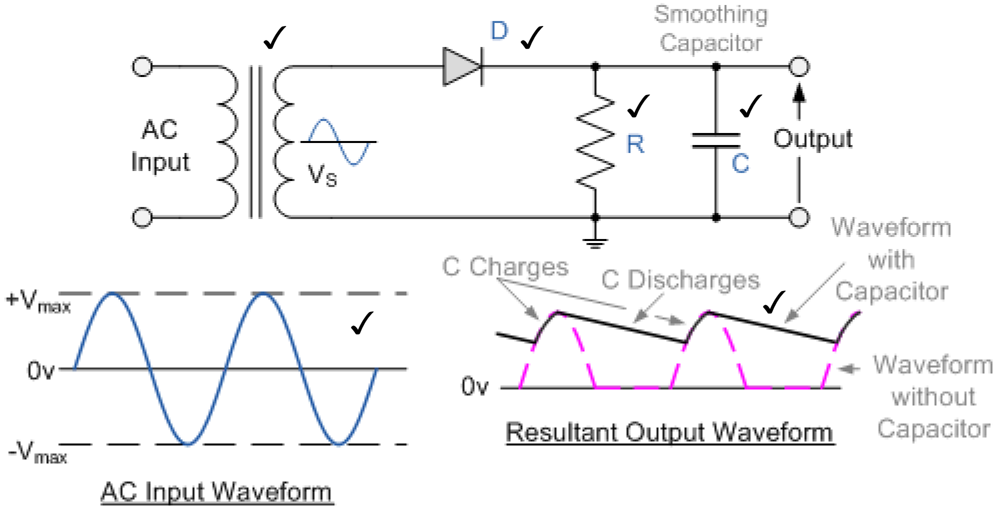
5.1



Forward bias occurs when the external voltage source is connected in such a way that its positive terminal is connected to the P-type material and its negative terminal is connected to the N-type material. The holes are repelled by the positive and the electrons are repelled by the negative. The depletion layer is reduced. If the biased voltage is increased so that it overcomes the barrier potential, electrons will flow freely. ✓✓

(2 MARKS FOR CIRCUIT DIAGRAM + 2 FOR EXPLANATION) (4)

5.2



(6)
[10]

QUESTION 6

6.1

- Accuracy is higher
- More robust (stronger)
  ALTERNATE ANSWERS
- Much more sensitive
- Error of parallax is eliminated
- Can handle negative quantities
- Reverse polarity is indicated by means of an indicator on the display.

(Any 2 x 1) (2)

6.2 6.2.1

$$R_{SH} = \frac{I_M \times R_M}{I_{SH}} \checkmark$$

$$= \frac{3\times10^{-3} \times 50}{27} \checkmark\checkmark$$

$$= 5{,}556\,\text{mA} \checkmark$$

(4)

6.2.2

$$V = 3\times10^{-3} \times 50 \checkmark$$

$$= 0{,}15\,\text{V} \checkmark$$

(2)

6.2.3

$$R_S = \frac{V_T}{I_M} - R_M \checkmark$$

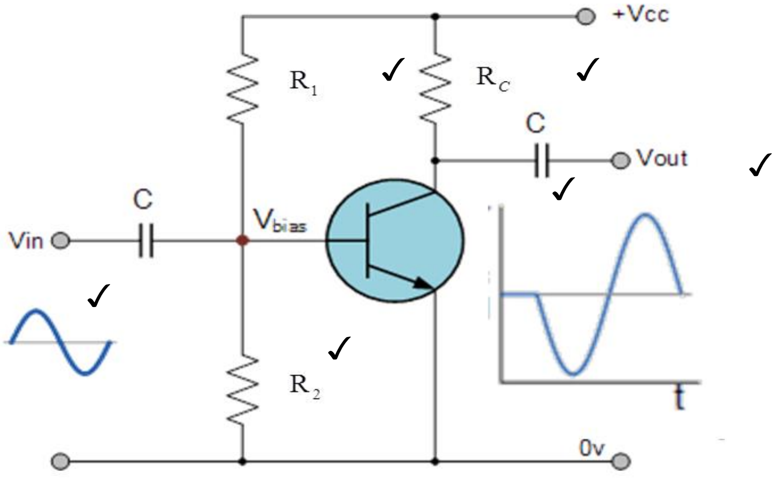
$$= \frac{12}{3\times10^{-3}} - 50 \checkmark\checkmark$$

$$= 3950\,\Omega \checkmark$$

(4)
[12]

QUESTION 7

7.1



(6)

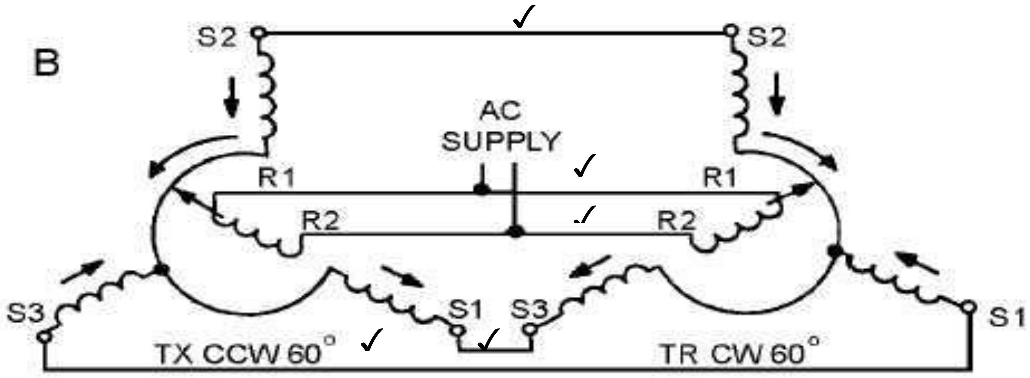
7.2 Class A ✓
Class B ✓
Class C ✓ (3)
[9]

QUESTION 8

8.1 Lenz's law states that when a magnetic field cuts through a coil and induces a voltage in the coil causing a current to flow,✓ that current will in turn generate its own magnetic field✓ which will oppose the original inducing magnetic field. ✓ (3)

8.2 Very little electrical energy is used by the synchro-system.√
Contact between the two systems can be by means of telemetering, radio or wires.✓
ALTERNATE ANSWER
The quantity to be controlled and the device from which control is given can be far apart. (2)

8.3



(5)
[10]

QUESTION 9

9.1 9.1.1 The thermocouple is a temperature-sensitive device consisting of two metals joined at the ends.✓ When one end is heated a potential difference is set up across the two ends.✓ The potential difference is proportional to the difference in temperature between the two ends.✓ (3)

9.1.2 Instead of generating a voltage, a bimetal strip indicates a change in temperature.✓ The two metals are bonded together and have different expansion coefficients.✓ When heat is applied one metal expands faster than the other thereby causing the bonded metal to bend.✓ (3)

9.2

$$P_O = \frac{V^2}{R} = \frac{(12)^2}{20} ✓ = 7,2W ✓$$

$$P_{IN} = I^2 \times R = (14 \times 10^{-3})^2 \times 15000 ✓ = 2,94\ W ✓$$

$$N = 10 \log \frac{7,2}{2,94} ✓$$

$$= 3,889\,\text{db} ✓$$

(6)
[12]

TOTAL: 100

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