Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2014

ELECTRICAL TECHNOLOGY

MARKS: 200

TIME: 3 hours

IELCTDM

This question paper consists of 9 pages including a formula sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Sketches and diagrams must be large, neat and fully labelled.
3. ALL calculations must be shown and correct to TWO decimal places.
4. Answers must be numbered correctly according to the numbering system used in this question paper.
5. A non-programmable calculators may be used.
6. A formula sheet is provided at the end of the question paper.

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

1.1 An employer is responsible for providing a safe working environment in an electrical workshop. Give THREE examples of what the employer must provide in order to meet his responsibility. (3)

1.2 Oscilloscopes are normally used to measure AC and DC voltages and to examine waveforms. Discuss the procedures that can be used to measure DC current with an oscilloscope. (5)

1.3 Why is it necessary to use an insulation tester when measuring insulation resistance? (2)

[10]

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

2.1 What is the difference between AC and DC? (2)

2.2 With the aid of a fully labelled sketch, describe how an EMF is induced in a conductive loop rotating in a two-pole magnetic field. (7)

2.3 A coil with 100 turns has an area of $0{,}01\text{m}^2$ and is rotated at 1 200 rpm about an axis through the centre and parallel with two sides in a uniform magnetic field of 0,4 T. Calculate:

2.3.1 The frequency (3)

2.3.2 The period (3)

2.3.3 The maximum value of the generated EMF (3)

2.3.4 The RMS value of the generated EMF (3)

2.3.5 The instantaneous value of the generated EMF when the coil is at a position 40 degrees after passing its maximum induced voltage. (3)

2.4 With reference to AC generators, answer the following questions:

2.4.1 How does the area of the coil affect the generated EMF? (2)

2.4.2 How do the numbers of pole pairs affect the frequency of the generated EMF? (2)

2.4.3 Why is it necessary to laminate the core used in generators? (2)

2.5 Describe the operation of a basic transformer. (6)

2.6 A certain household in a rural area uses 10 sixty Watt, 220 Volt light bulbs, kitchen appliances that consume 2,2 kW at 220 Volts, a hot water geyser that draws 8 Amps at any given time. The ESKOM supply is 11 kV. Calculate:

2.6.1 The total current drawn by the household when all lights, appliances and geyser are drawing current (8)

2.6.2 The VA rating of the transformer used to supply the household (3)

2.6.3 The transformation ratio of the transformer (3)
[50]

QUESTION 3: SINGLE-PHASE MOTORS AND PROTECTION DEVICES

3.1 Name the THREE main parts of a single-phase induction motor. (3)

3.2 Draw a neat, fully labelled circuit diagram of a capacitor start and run induction motor. (5)

3.3 Describe how a rotating magnetic field is obtained in a split-phase motor. (4)

3.4 State THREE consequences that may result when electrical machinery draws too much current. (3)

3.5 Explain the operation of the no-volt coil in an electric motor starter. (4)

3.6 Draw a neat, fully labelled circuit diagram of a direct-on-line starter for a single-phase induction motor. (6)

3.7 Before a single-phase motor is put into service, various electrical tests need to be done. A continuity test and insulation test. The insulation test comprises two operations.

3.7.1 What is the purpose of the continuity test? (1)

3.7.2 Name the TWO operations involved in the insulation test. (2)

3.7.3 State which test instrument must be used for the insulation test. (1)

3.7.4 What readings are acceptable? (1)
[30]

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

4.1 Describe what is meant by forward bias and reverse bias with reference to diodes. (4)

4.2 Name THREE practical applications of thyristors. (3)

4.3 Describe, with the aid of a circuit diagram, the operation of a SCR. Use the two transistor analogy. (6)

4.4 How is a TRIAC and a DIAC switched on? (2)

4.5 In a lamp dimming circuit, what is the DISADVANTAGE of controlling the brightness by means of a variable resistor connected in series? (2)

4.6 Draw a labelled block diagram of an unregulated DC power supply. (3)

4.7 Draw a fully labelled circuit diagram of a series regulator that uses a transistor. (5)

4.8 Why are large value capacitors used to filter out the ripple in DC power supplies rather than π filters? (2)

4.9 4.9.1 With reference to the transistor load line, what is meant by the Q-point? (3)

4.9.2 How is the output of a transistor influenced when biased in class B? (1)

4.9.3 Where is Class B used? (2)

4.10 Transistor amplifier circuits are configured in one of three ways, namely common-base, common collector, and common-emitter. Give ONE characteristic of each configuration. (3)

4.11

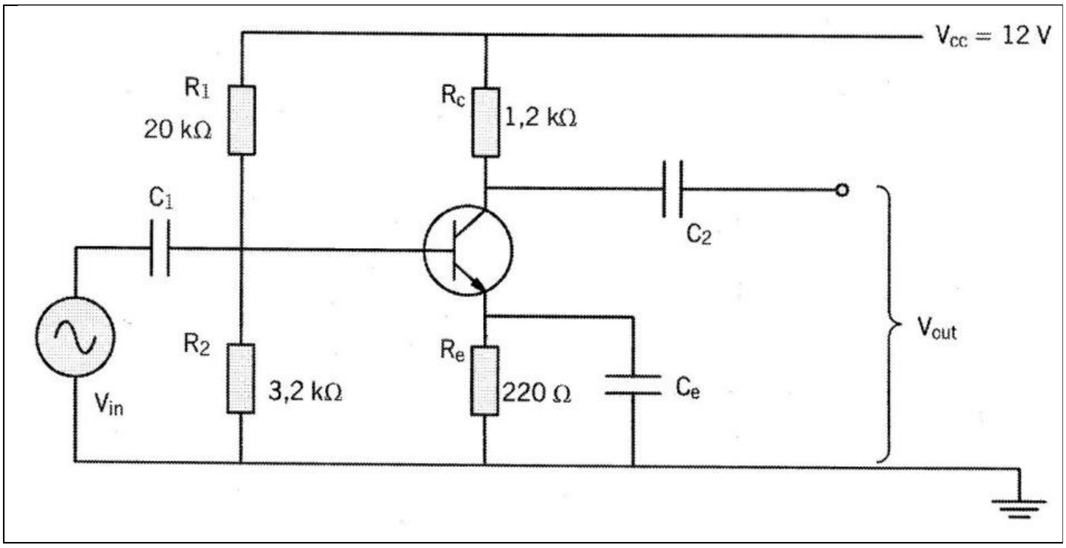


FIGURE 4.10

Draw a neat DC load line for the circuit shown in FIGURE 4.10. Show all calculations. (7)

4.12 Give THREE advantages of negative feedback. (3)

4.13 What is meant by "*thermal runaway*" with reference to common emitter transistor amplifiers, and how can thermal runaway be prevented? (4)

[50]

QUESTION 5: RLC SERIES CIRCUITS

5.1 5.1.1 How is the reactance of a capacitor influenced by a decrease in frequency? (1)

5.1.2 How is the reactance of an inductor influenced by a decrease in frequency? (1)

5.1.3 Define the term "*impedance*". (2)

5.1.4 State TWO characteristics of an RLC circuit at resonance. (2)

5.2 A series AC circuit consists of an 11 Ω resistor, a 100 mH inductor, and a 47 µF capacitor. The circuit is connected across a 220 V, 50 Hz supply. Calculate:

5.2.1 The impedance of the circuit (9)

5.2.2 Will this circuit have a leading, or lagging power factor? (1)

5.2.3 At what frequency will this circuit resonate? (4)

[20]

QUESTION 6: LOGIC

6.1 Create an OR gate using NAND gates. Make use of your knowledge of logic circuits and Boolean expressions. (5)

6.2 You are required to design a half-adder.

6.2.1 Write down the truth table for a half adder. (2)

6.2.2 From the truth table for a half adder derive the sum-of-products expression for the Sum and carry outputs. (2)

6.2.3 Use NAND gates, AND gates and OR gates in the design. (5)

6.3 Prove:

$$\overline{A.B + \bar{A}.\bar{B}} = A.\bar{B} + \bar{A}.B$$ (6)

[20]

QUESTION 7: COMMUNICATIONS

7.1 State whether the following statements are TRUE or FALSE.

7.1.1 A single repeater system requires two separate frequencies. (1)

7.1.2 The receiver of a repeater is tuned to the transmit frequency of mobile radios. (1)

7.1.3 The transmitter of a repeater transmits on the receive frequency of mobile radios. (1)

7.1.4 The wavelength of an electromagnetic signal is the speed of light multiplied by the frequency of the signal. (1)

7.1.5 The gain of an antenna is determined by the radiation of the antenna. (1)

7.1.6 Radio propagation is a term used to explain how radio waves behave when they transmit. (1)

7.2 In both AM and FM receivers, mixers and IF amplifiers are used.

7.2.1 Explain the function of the mixer in both types of receivers. (8)

7.2.2 Explain the function of the IF amplifier. (2)

7.3 An AM receiver uses a detector. An FM receiver uses a discriminator. Compare the two forms of demodulation. (4)

[20]

TOTAL: 200

ELECTRICAL TECHNOLOGY GRADE 11

FORMULA SHEET

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_n}$	$e = EmSin\theta$
$Rs = R1 + R2 + R3 + ...Rn$	$\omega = 2\pi F$
$I = \frac{V}{R}$	$E_{rms} = Em \times 0.707$
$R = \frac{V}{I}$	$E_{ave} = Em \times 0,637$
$V = I \times R$	$E_{wgk} = Em \times 0,707$
$P = V \times I$	$E_{gem} = Em \times),637$
$P = I^2 \times R$	$X_L = 2\pi FL$
$P = \frac{V^2}{R}$	$X_C = \frac{1}{2\pi FC}$
$R_t = R_o(1 + \infty_o t)$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
$R = \frac{\rho l}{a}$	$I_Z = \sqrt{I_R{}^2 + (I_{XL} - I_{XC})^2}$
$\tau = R \times C$	$V_Z = \sqrt{V_R{}^2 + (V_{XL} - V_{XC})^2}$
$\tau = \frac{R}{L}$	$F_R = \frac{1}{2\pi\sqrt{LC}}$
$a = \frac{\pi d^2}{4}$	$Gain = \frac{Vout}{Vin}$
$Pf = Cos\ \theta$	$Wins = \frac{Vuit}{Vin}$
$V_{RB} = Vcc - V_B$	$Ic = \frac{Vcc}{Rc}$
	$\frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is}$
	$S = Vp \times Ip$
	$\overline{A.B} = \overline{A} + \overline{B}$
	$T = \frac{1}{F}$
	$V = V/_{Div} \times Div$
	$Iz = \frac{Vz}{Z}$
	$P = V.I.Cos\theta$
	$P_S = VI$
	$V_O = V_{Zener} - V_{basis}$
	$V_{CE} = V_I - V_O$

ELEKTRIESE TEGNOLOGIE GRAAD 11

FORMULEBLAD

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_n}$$

$$Rs = R1 + R2 + R3 + \text{........}Rn$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

$$V = I \times R$$

$$P = V \times I$$

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

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

$$R_t = R_o(1 + \infty_o t)$$

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

$$\tau = R \times C$$

$$\tau = \frac{R}{L}$$

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

$$Pf = Cos\ \theta$$

$$V_{RB} = Vcc - V_B$$

$$e = EmSin\theta$$

$$\omega = 2\pi F$$

$$E_{rms} = Em \times 0.707$$

$$E_{ave} = Em \times 0{,}637$$

$$E_{wgk} = Em \times 0{,}707$$

$$E_{gem} = Em \times),637$$

$$X_L = 2\pi FL$$

$$X_C = \frac{1}{2\pi FC}$$

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

$$I_Z = \sqrt{I_R^{\ 2} + (I_{XL} - I_{XC})^2}$$

$$V_Z = \sqrt{V_R^{\ 2} + (V_{XL} - V_{XC})^2}$$

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

$$Gain = \frac{Vout}{Vin}$$

$$Wins = \frac{Vuit}{Vin}$$

$$Ic = \frac{Vcc}{Rc}$$

$$\frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is}$$

$$S = Vp \times Ip$$

$$\overline{A.B} = \overline{A} + \overline{B}$$

$$T = \frac{1}{F}$$

$$V = {}^{V}\!/_{Div} \times Div$$

$$Iz = \frac{Vz}{Z}$$

$$P = V.I.Cos\theta$$

$$P_S = VI$$

$$V_O = V_{Zener} - V_{basis}$$

$$V_{CE} = V_I - V_O$$

VRAAG 7: KOMMUNIKASIE

7.1 Dui aan of die volgende verklarings WAAR of ONWAAR is.

7.1.1 ŉ Enkel herhalerstelsel het twee aparte frekwensies nodig. (1)

7.1.2 Die ontvanger van ŉ herhaler is tot die uitsaai-frekwensie van die mobiele radio's ingestel. (1)

7.1.3 Die sender van ŉ herhaler saai op die ontvangsfrekwensie van die mobiele radio's uit. (1)

7.1.4 Die golflengte van ŉ elektromagnetiese sein is die spoed van lig, vermenigvuldig met die frekwensie van die sein. (1)

7.1.5 Die wins van ŉ antenna word deur die uitstraling van die antenna bepaal. (1)

7.1.6 Radiovoortplanting is die term wat gebruik word om die gedrag van radiogolwe wat uitgesaai word te verduidelik. (1)

7.2 In beide AM- en FM-ontvangers, word mengers en IF-versterkers gebruik.

7.2.1 Verduidelik die funksie van die menger in beide tipes van ontvangers. (8)

7.2.2 Verduidelik die funksie van die IF-versterker. (2)

7.3 ŉ AM-ontvanger maak gebruik van ŉ detektor. ŉ FM-ontvanger gebruik ŉ diskriminator. Vergelyk die twee vorme van demodulasie. (4)

[20]

TOTAAL: 200

VRAAG 5: RLC SERIE STROOMBANE

5.1 5.1.1 Hoe word die reaktansie van 'n kapasitor beïnvloed deur 'n afname in die frekwensie? (1)

5.1.2 Hoe word die reaktansie van 'n induktor beïnvloed deur 'n afname in die frekwensie? (1)

5.1.3 Definieer die term *"impedansie"*. (2)

5.1.4 Noem TWEE kenmerke van 'n RLC-kring by resonansie. (2)

5.2 'n Serie WS-kring bestaan uit 'n 11 Ω weerstand, 'n 100 mH induktor, en 'n 47μF kapasitor. Die kring is oor 'n 220 V, 50 Hz toevoer gekoppel.
Bereken:

5.2.1 Die impedansie van die kring. (9)

5.2.2 Sal hierdie kring 'n voorlopende, of nalopende arbeidsfaktor hê? (1)

5.2.3 Op watter frekwensie sal hierdie kring resoneer? (4)

[20]

VRAAG 6: LOGIKA

6.1 Skep 'n OF-hek deur NEN hekke te gebruik. Maak gebruik van jou kennis van logika en Boole uitdrukkings. (5)

6.2 Dit word van jou verwag om 'n half-sommeerder te ontwerp.

6.2.1 Skryf die waarheidstabel vir 'n half-sommeerder neer. (2)

6.2.2 Gebruik die waarheidstabel van 'n half-sommeerder om 'n som-van-produk uitdrukking van die uitsette te bepaal. (2)

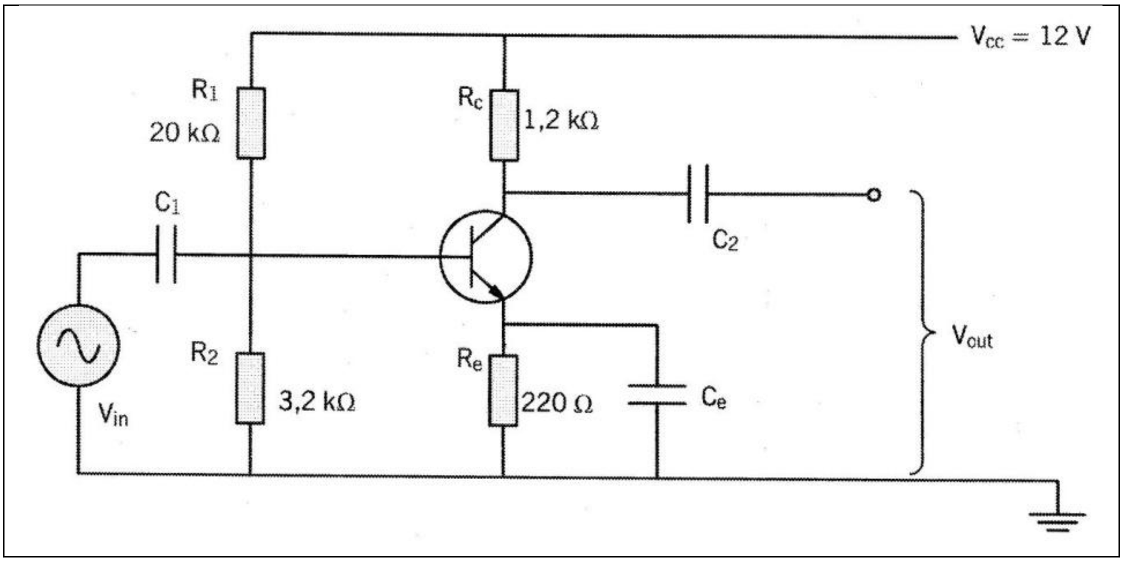
6.2.3 Gebruik NEN-hekke, EN-hekke en OF-hekke in jou ontwerp. (5)

6.3 Bewys dat die volgende uitdrukking waar is:

$$\overline{A.B + \bar{A}.\bar{B}} = A.\bar{B} + \bar{A}.B$$ (6)

[20]

4.11



FIGUUR 4.10

Teken 'n netjiese GS laslyn vir die kring in FIGUUR 4.10. Wys alle berekeninge. (7)

4.12 Noem DRIE voordele van negatiewe terugvoer. (3)

4.13 Wat word bedoel met "*termiese weghol*" met verwysing na gemeenskaplike emittor transistor versterkers, en hoe kan termiese weghol voorkom word? (4)

[50]

VRAAG 4: HALFGELEIERTOESTELLE, KRAGBRONNE, EN VERSTERKERS

4.1 Beskryf wat by voorspanning en teenvoorspanning met verwysing na ŉ diode bedoel word. (4)

4.2 Noem DRIE praktiese gebruike van tiristors. (3)

4.3 Beskryf, met behulp van ŉ kringdiagram, die werking van ŉ SBG. Gebruik die twee transistor analogie. (6)

4.4 Hoe word ŉ TRIAK en ŉ DIAK aangeskakel? (2)

4.5 Met verwysing na ŉ lampverdoofkring, wat is die NADEEL wanneer die helderheid van die lamp deur ŉ serieverstelbare weerstand beheer word? (2)

4.6 Teken ŉ benoemde blokdiagram van ŉ ongereguleerde GS kragbron. (3)

4.7 Teken ŉ volle benoemde kringdiagram van ŉ serie-reguleerder wat ŉ transistor gebruik. (5)

4.8 Waarom word groot waarde kapasitors gebruik om die rimpeleffek in GS kragbronne uit te filter, eerder as π filters? (2)

4.9 4.9.1 Met verwysing na die transistor-laslyn, wat word met die Q-punt bedoel? (3)

4.9.2 Hoe word die uitset van ŉ transistor beïnvloed wanneer die transistor as ŉ Klas B versterker voorgespan word? (1)

4.9.3 Waar word Klas B versterker gebruik? (2)

4.10 Transistor versterkerkringe word in een van drie konfigurasies gekoppel, naamlik, gemeenskaplike-basis, gemeenskaplike kollektor en gemeenskaplike emittor. Gee EEN kenmerk van elke verbinding. (3)

2.6 ʼn Sekere landelike huisgesin gebruik 10 sestig Watt, 220 Volt gloeilampe, kombuistoestelle wat 2,2 kW teen 220 Volt gebruik, en ʼn warmwatertoestel wat 8 Ampère op enige gegewe tyd trek. Die ESKOM toevoer is 11 kV. Bereken:

2.6.1 Die totale stroom wat gebruik word wanneer al die ligte, kombuistoestelle en die warmwatertoestel aangeskakel is. (8)

2.6.2 Die VA-aanslag van die transformator wat gebruik moet word om die toevoer te voorsien. (3)

2.6.3 Die draaiverhouding van die transformator. (3)

[50]

VRAAG 3: ENKELFASE-MOTORS EN BESKERMINGSTOESTELLE

3.1 Noem die DRIE hoofonderdele van ʼn enkelfase-induksiemotor. (3)

3.2 Teken ʼn netjiese, volle benoemde kringdiagram van ʼn enkelfasige kapasitor-aansit kapasitor-loop induksiemotor. (5)

3.3 Beskryf hoe ʼn roterende magneetveld in ʼn splitfase-motor verkry word. (4)

3.4 Noem DRIE gevolge wanneer elektriese masjinerie te veel stroom trek. (3)

3.5 Verduidelik die werking van die nul-volt-spoel in ʼn elektriese motoraansitter. (4)

3.6 Teken ʼn netjiese, volle benoemde kringdiagram van ʼn direk-op-lyn aansitter vir ʼn enkelfase-induksiemotor. (6)

3.7 Voordat ʼn enkelfase-motor in diens geneem word, is dit nodig dat verskeie elektriese toetse gedoen moet word. ʼn Kontinuïteit-toets en ʼn isolasie-toets. Die isolasie-toets bestaan uit twee operasies.

3.7.1 Wat is die doel van die kontinuïteit-toets? (1)

3.7.2 Noem die TWEE operasies wat by die isolasie-toets betrokke is. (2)

3.7.3 Noem die toetsinstrument wat vir die isolasie-toets gebruik moet word. (1)

3.7.4 Watter lesings is aanvaarbaar? (1)

[30]

VRAAG 1: BEROEPSVEILIGHEID EN GESONDHEID, GEREEDSKAP EN MEETINSTRUMENTE

1.1 ʼn Werkgewer is verantwoordelik om ʼn veilige werkomgewing in ʼn elektriese werkswinkel te voorsien. Gee DRIE voorbeelde wat die werkgewer moet voorsien om sy verantwoordelikheid na te kom. (3)

1.2 Ossilloskope word normaalweg gebruik om WS en GS spanning te meet en golfvorms te ondersoek. Bespreek die prosedure wat gebruik kan word om GS stroom met ʼn ossilloskoop te meet. (5)

1.3 Waarom is dit nodig om ʼn isolasie toets-instrument te gebruik wanneer isolasie-weerstand getoets word? (2)

[10]

VRAAG 2: ENKELFASE WS-OPWEKKING ENKELFASE TRANSFORMATORS

2.1 Wat is die verskil tussen WS en GS? (2)

2.2 Beskryf met behulp van ʼn volledige genoteerde skets, hoe ʼn EMK in ʼn geleierlus wat deur ʼn twee-pool magnetiese veld roteer, geïnduseer word. (7)

2.3 ʼn Spoel van 100 draaie en ʼn area van 0,01 m^2, roteer teen 1200 opm, in ʼn eenvormige magneetveld van 0,4 T. Bereken:

2.3.1 Die frekwensie (3)

2.3.2 Die periode (3)

2.3.3 Die maksimum waarde van die opgewekte EMK (3)

2.3.4 Die WGK waarde van die opgewekte EMK (3)

2.3.5 Die oombliklike waarde van die opgewekte EMK, 40 grade na sy maksimum geïnduseerde waarde (3)

2.4 Met verwysing na WS kragopwekkers, beantwoord die volgende vrae:

2.4.1 Hoe word die opgewekte EMK deur die oppervlakte van die spoel beïnvloed? (2)

2.4.2 Hoe kan die aantal poolpare die frekwensie van die opgewekte EMK beïnvloed? (2)

2.4.3 Hoekom is dit nodig om die kern wat in kragopwekkers gebruik word, te lamineer? (2)

2.5 Beskryf die werking van ʼn basiese transformator. (6)

INSTRUKSIES EN INLIGTING

1. Beantwoord AL die vrae.

2. Sketse en diagramme moet groot, netjies en van volledige byskrifte voorsien wees.

3. ALLE berekeninge moet getoon word en korrek tot TWEE desimale.

4. Nommer die antwoorde korrek volgens die nommeringstelsel wat in hierdie vraestel gebruik is.

5. ʼn Nieprogrammeerbare sakrekenaar mag gebruik word.

6. 'n Formuleblad word aan die einde van die vraestel voorsien.

Province of the
EASTERN CAPE
EDUCATION

NASIONALE
SENIOR SERTIFIKAAT

GRAAD 11

NOVEMBER 2014

ELEKTRIESE TEGNOLOGIE

PUNTE: **200**

TYD: **3 uur**

IELCTDM

Hierdie vraestel bestaan uit 9 bladsye insluitend 'n formuleblad.