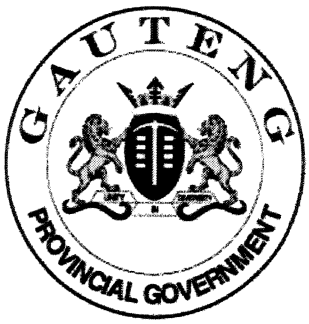
SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN



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TECHNIKA (ELECTRICAL)

TECHNIKA (ELEKTRIES)

HG **713-1/0**

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TECHNIKA ELECTRICAL HG

713 1 0 HG

APPROVED BY UMALUSI / *GOEDGEKEUR DEUR UMALUSI*

GAUTENGSE DEPARTEMENT VAN ONDERWYS

SENIORSERTIFIKAAT-EKSAMEN

TECHNIKA (ELEKTRIES) HG

TYD: 3 uur

PUNTE: 300

BENODIGDHEDE:

Tekeninstrumente en 'n goedgekeurde sakrekenaar.

INSTRUKSIES:

- Beantwoord AL die vrae.
- Sketse en diagramme moet duidelik en netjies wees.
- Alle formules en berekeninge moet, waar van toepassing, getoon word.
- 'n Lys van formules wat gebruik mag word waar van toepassing, word op die laaste bladsy van hierdie eksamenvraestel verskaf.

VRAAG 1
WISSELSTROOMTEORIE

1.1 Verduidelik wat verstaan word onder die term **fasor**. (1)

1.2 In 'n wisselstroomkring, hoe beïnvloed die verhoging in frekwensie die stroom in 'n induktiewe las? (2)

1.3 'n Spoel met 'n weerstand en induktansie word saam met 'n kapasitor in serie gekoppel aan 'n toevoer met 'n verstelbare frekwensietoevoer. Verduidelik, met behulp van 'n fasordiagram, aan watter voorwaardes voldoen moet word sodat die kring soos 'n nie-reaktiewe resistor sal reageer. (4)

1.4 'n Spoel met 'n weerstand van 12 ohm en 'n induktansie van 0,15 henry en 'n kapasitor van 100 mikrofarad is in serie aan 'n 200 volt, 50 Hz-toevoer verbind.

1.4.1 Bereken die impedansie van die kring. (9)

1.4.2 Bereken die fasehoek. (3)

1.4.3 Teken 'n fasordiagram van die kring (nie volgens skaal nie). (7)

1.4.4 Hoe sal die reaktansie van die kapasitor deur 'n verhoging in frekwensie beïnvloed word? (1)

GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRICAL) HG

TIME: 3 hours

MARKS: 300

REQUIREMENTS:

Drawing instruments and an approved calculator.

INSTRUCTIONS:

- Answer ALL the questions.
- Sketches and diagrams must be clear and neat.
- All formulae and calculations must, where applicable, be indicated.
- A list of formulae which could be used where appropriate, is given on the last page of this question paper.

QUESTION 1
ALTERNATING CURRENT THEORY

1.1 Explain what is meant by the term **phasor**. (1)

1.2 In an alternating current circuit, how does an increase in frequency influence the current in an inductive load? (2)

1.3 A coil with a resistance and inductance is connected in series with a capacitor to a variable frequency supply. Explain with the aid of a phasor diagram, the conditions which must be satisfied so that the circuit will react as a non-reactive resistor. (4)

1.4 A coil with a resistance of 12 ohms and an inductance of 0,15 henrys and capacitor of 100 micro-farads is connected in series to a 200 volt 50 Hz supply.

1.4.1 Calculate the impedance of the circuit. (9)

1.4.2 Calculate the phase angle. (3)

1.4.3 Draw a phasor diagram of the circuit (not to scale). (7)

1.4.4 How will the reactance of the capacitor be influenced by an increase in frequency? (1)

1.5 Die weerstandkomponent van 'n parallel resonante kring, bestaande uit R, L en C, is 5 ohm. Die kring resoneer teen 'n frekwensie van 550 kHz wanneer die kapasitor 'n kapasitansie van 500 piko-farad het.

1.5.1 Bereken die Q-faktor van die kring. (4)

1.5.2 Bepaal die stroom wat tussen die spoel en die kapasitor sirkuleer as die toevoerstroom na die kring 50 mikro-ampère is. (8)

1.6 Die drywingsfaktor van 'n 230 volt-installasie is 0,866 nalopend, en die stroom wat vanaf die toevoer getrek word, is 24 ampère.

Gebruik 'n skaal van 1 cm = 2 A om die stroomfasordiagram van die installasie te teken. (5)

Bepaal vanaf die fasordiagram die waarde van die

1.6.1 aktiewe komponent van die stroom. (2)

1.6.2 reaktiewe komponent van die stroom. (2)

1.6.3 stroom wat deur 'n kapasitor wat in die kring verbind word, geneem sal word, indien dit die drywingsfaktor soveel verbeter dat die fasehoek halveer. (2)

[50]

VRAAG 2
EEN- EN DRIE-FASIGE WISSELSTROOMSTELSELS

2.1 'n Kapasitiewe, deltaverbinde, driefaselas met 'n toevoerspanning van 380 V, lewer 20 kW teen 'n rendement van 90 % en 'n drywingsfaktor van 0,95.

Bereken die volgende:

2.1.1 Lynstroom (4)

2.1.2 Fasestroom (3)

2.1.3 Fasespanning (2)

2.1.4 Fasehoek (2)

2.1.5 Fase-impedansie (3)

2.1.6 Faseweerstand (3)

2.1.7 Fasereaktansie (3)

1.5 The resistance component of a parallel resonant circuit consisting of R, L and C, is 5 ohms. The circuit resonates at a frequency of 550 kHz when the capacitor has a capacitance of 500 pico-farads.

1.5.1 Calculate the Q-factor of the circuit. (4)

1.5.2 Calculate the current circulating between the coil and the capacitor if the supply current to the circuit is 50 micro-amperes. (8)

1.6 The power factor of a 230 volt installation is 0,866 lagging and the current drawn from the supply is 24 amperes.

By using a scale of 1 cm = 2 A, construct the current-phasor diagram of the installation. (5)

Determine from the phasor diagram the value of the

1.6.1 active component of the current. (2)

1.6.2 reactive component of the current. (2)

1.6.3 current taken by a capacitor which, when it is connected in the circuit to improve the power factor, will bisect the phase angle. (2)

[50]

QUESTION 2
SINGLE AND THREE-PHASE SYSTEMS

2.1 A capacitive, delta-connected, three-phase load with a supply voltage of 380 V, delivers 20 kW at an efficiency of 90 % and a power factor of 0,95.

Calculate the following:

2.1.1 Line current (4)

2.1.2 Phase current (3)

2.1.3 Phase voltage (2)

2.1.4 Phase angle (2)

2.1.5 Phase impedance (3)

2.1.6 Phase resistance (3)

2.1.7 Phase reactance (3)

2.2 Die meterlesings in 'n sekere eenfasestelsel is:

V = 220 V en I = 30 A

Die drywingsfaktor is 0,8 voorlopend.

2.2.1 Bereken die skyndrywing van die kring. (3)

2.2.2 Bereken die effektiewe drywing van die kring. (3)

2.2.3 Bereken die fasehoek tussen die stroom en die spanning. (3)

2.2.4 Skets, volgens enige geskikte skaal, die fasordiagram van die kring en meet die aktiewe en reaktiewe komponente van die stroom. (5)

2.2.5 Hoe kan die drywingsfaktor van hierdie kring verbeter word? (2)

2.3 Noem VYF voordele van 'n driefasestelsel bo 'n enkelfasestelsel. (5)
[41]

VRAAG 3
TRANSFORMATORS

3.1 'n Toevoer van 200 volt word toegepas oor 550 windings van 'n outotransformator met 600 windings. Die vermoë van die transformator is 750 VA.

3.1.1 Teken 'n volledig benoemde diagrammatiese voorstelling van die transformator. (3)

3.1.2 Bereken die grootte (waarde) van die sekondêre spanning. (4)

3.1.3 Bereken die sekondêre stroom wat die transformator by vollas kan verskaf. (4)

3.1.4 Noem een voordeel van hierdie tipe transformator in vergelyking met 'n dubbelbewikkelde transformator. (2)

3.2 Watter voorsorgmaatreël moet getref word voordat 'n ammeter wat aan 'n stroomtransformator gekoppel is, verwyder mag word? (2)

2.2 The meter readings in a certain single-phase system are:

V = 220 V and I = 30 A

The power factor is 0,8 leading.

2.2.1 Calculate the apparent power of the circuit. (3)

2.2.2 Calculate the effective power of the circuit. (3)

2.2.3 Calculate the phase angle between the current and the voltage. (3)

2.2.4 Sketch, to any convenient scale, the phasor diagram of the circuit and measure the active and reactive components of the current. (5)

2.2.5 How can the power factor of this circuit be improved? (2)

2.3 State FIVE advantages of a three-phase system over a single-phase system. (5)
[41]

QUESTION 3
TRANSFORMERS

3.1 A supply of 200 volts is applied to 550 turns of an auto-transformer with 600 turns. The transformer is rated at 750 VA.

3.1.1 Sketch a fully labelled diagrammatic representation of the transformer. (3)

3.1.2 Calculate the value of the secondary voltage. (4)

3.1.3 Calculate the secondary current which the transformer can supply at full load. (4)

3.1.4 State one advantage of this type of transformer compared to a double-wound transformer. (2)

3.2 What precaution must be taken before an ammeter, which is connected to a current transformer, may be removed? (2)

3.3 'n Sterverbinde, driefase-alternator met 'n fasespanning van 6,6 kV word aan drie identiese eenfasetransformators, elk met 'n draaiverhouding van 17,5:1, gekoppel. Die transformators is in delta-ster gekoppel.

Bereken:

3.3.1 Die sekondêre lynspanning (9)

3.3.2 Die sekondêre fasestroom wanneer die transformator 20 kW lewer aan 'n lading wat 'n drywingsfaktor van 0,8 het, indien die rendement van die transformator 97% is. (5)
[29]

VRAAG 4
WISSELSTROOMMOTORS

4.1 Bereken die sinchrone spoed van 'n vierpool-induksiemotor indien die toevoer-frekwensie 50 Hz is. (3)

4.2 Wat bepaal die frekwensielewering van 'n alternator? (2)

4.3 Verduidelik kortliks waarom 'n induksiemotor nie teen sinchrone spoed kan loop nie. (4)

4.4 Wat is die funksie van die sentrifugale skakelaar in 'n enkelfasige induksiemotor? (2)

4.5 'n Eenfasige motor trek 'n stroom van 15 ampère teen 'n arbeidsfaktor van 0,85 vanaf 'n 380 volt-toevoer.

Bereken:

4.5.1 Die kragverbruik van die motor (3)

4.5.2 Die aktiewe en reaktiewe komponente van die stroom (6)

4.6 Toon deur middel van TWEE kringdiagramme die verskil tussen 'n kapasitor-aansitmotor en 'n kapasitoraansit-en-loopmotor. (10)
[30]

3.3 A star-connected three-phase alternator with a phase voltage of 6,6 kV is connected to three identical single-phase transformers each having a turns ratio of 17,5:1. The transformers are connected in delta-star.

Calculate:

3.3.1 The secondary line voltage (9)

3.3.2 The secondary phase current when the transformer delivers 20 kW to a load having a power factor of 0,8 if the efficiency of the transformer is 97%. (5)

[29]

QUESTION 4
ALTERNATING CURRENT MOTORS

4.1 Calculate the synchronous speed of a four-pole induction motor if the supply frequency is 50 Hz. (3)

4.2 What determines the frequency output of an alternator? (2)

4.3 Explain briefly why an induction motor cannot run at synchronous speed. (4)

4.4 What is the function of the centrifugal switch in a single-phase induction motor? (2)

4.5 A single-phase motor draws a current of 15 amperes at a power factor of 0,85 from a 380 volt supply.

Calculate:

4.5.1 The power consumption of the motor (3)

4.5.2 The active and reactive components of the current (6)

4.6 Show by means of TWO circuit diagrams the difference between a capacitor-start and a capacitor-start-and-run motor. (10)

[30]

VRAAG 5
HALFGELEIERS EN SKAKEL- EN BEHEERKRINGE

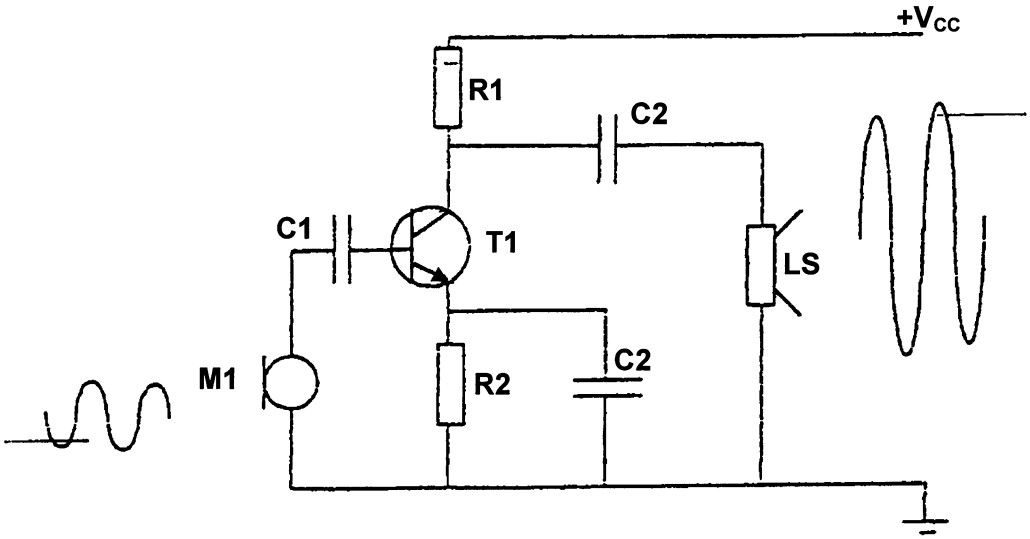
5.1 Verduidelik met behulp van 'n netjies benoemde kringdiagram, die werkbeginsel van 'n Beheerde Silikon Gelykrigter (BSG) wat van twee transistors gebruik maak. (5)

5.2 Die kringdiagram in **Figuur 5.2** toon 'n gemeenskaplike emittorversterker.

5.2.1 Sal die kringdiagram in **Figuur 5.2** die insetsein korrek versterk? Gee 'n rede vir jou antwoord. (2)

5.2.2 Wat is die doel van **C1** op die basis van **T1**? (2)

5.2.3 Verduidelik waarom die uitsetsein van die versterker verskil van die inset met betrekking tot fase en vorm. (2)



Figuur 5.2

5.3 Die spoedbeheer van 'n elektriese motor kan op verskeie maniere gedoen word. Teken 'n volledige kringdiagram waar jy van of 'n BSG of 'n triak gebruik maak om die funksie te kan uitvoer. (8)

5.4 Verduidelik die betekenis van die begrip **gereguleerde kragbron**. (3)

QUESTION 5
SEMICONDUCTORS AND SWITCHING AND CONTROL CIRCUITS

5.1 Explain by means of a neatly labelled circuit diagram the principle of the operation of a Silicon-Controlled Rectifier (SCR) using two transistors. (5)

5.2 The circuit diagram in **Figure 5.2** shows a common emitter amplifier.

5.2.1 Will the circuit diagram in **Figure 5.2** correctly amplify the input-signal? Explain your answer. (2)

5.2.2 What is the purpose of **C1** on the base of **T1**? (2)

5.2.3 Explain why the output waveform differs from the input in relation to phase and shape. (2)

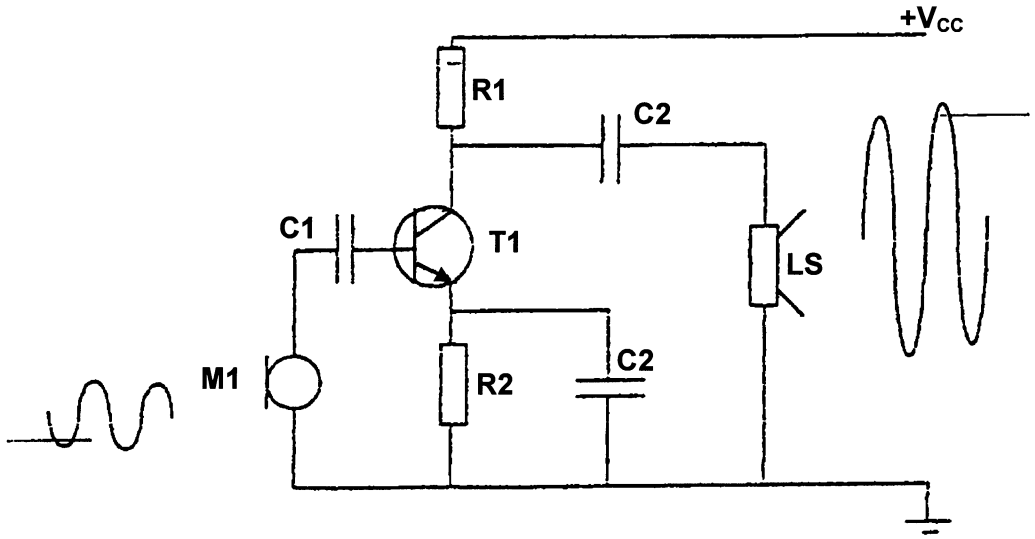


Figure 5.2

5.3 The speed control of an electrical motor can be done in different ways. Draw a complete circuit diagram where you use either an SCR or a triac to perform this function. (8)

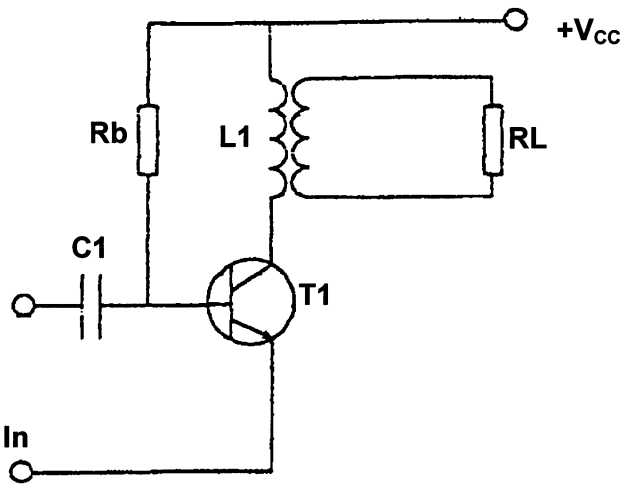
5.4 Explain the meaning of the term **regulated power supply**. (3)

5.5 'n Praktiese kragbron kan ontwerp word om 'n toevoerspanning van 220 V na 'n meer bruikbare GS-spanning om te skakel. Ontwerp 'n eenvoudige 12 volt GS gereguleerde kragbronkring, wat in staat is om 'n konstante uitsetspanning onder veranderende lastoestande te lewer. Jou kring moet van 'n verlagingstransformator, 'n diode-gelykrigterkring, 'n filtreerkring en 'n sjunt-reguleerder voorsien wees. Al die relevante golfvorms moet aangedui word.

(Neem asseblief kennis dat hierdie nie 'n blokdiagram moet wees nie.) (18)
[40]

VRAAG 6
VERSTERKERS

6.1 **Figuur 6.1** illustreer 'n enkeltrap, klas A-versterker.



Figuur 6.1

6.1.1 Benoem die koppelingsmetode wat in die versterker in **Figuur 6.1** gebruik word. (2)

6.2 Illustreer klas B-versterking deur die invoer- en afvoerkurwes in 'n netjies benoemde skets op die emittorafvoerkenkromme te projekteer. (5)

5.5 A practical power supply can be designed to convert a 220 V supply voltage into a desired DC voltage. Design a simple 12 volt DC regulated power supply circuit to maintain an essentially constant output voltage under changing load conditions. Your circuit should include a step-down transformer, a diode rectifier circuit, a filter circuit and a shunt regulator. All the relevant wave forms should be indicated.

(Please note that this should not be a block diagram.) (18)
[40]

QUESTION 6
AMPLIFIERS

6.1 **Figure 6.1** illustrates a single stage Class A amplifier.

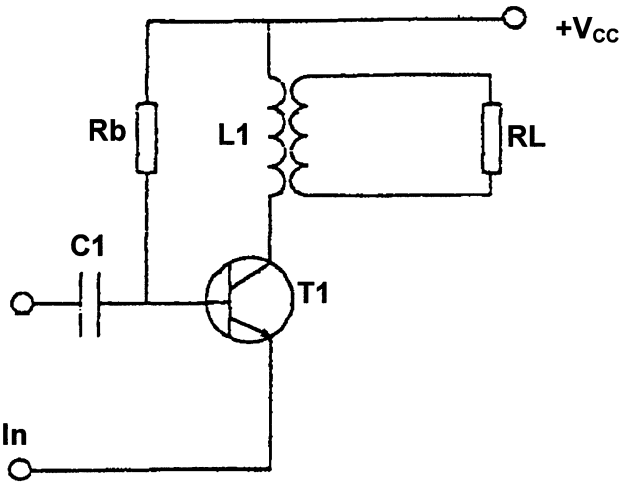
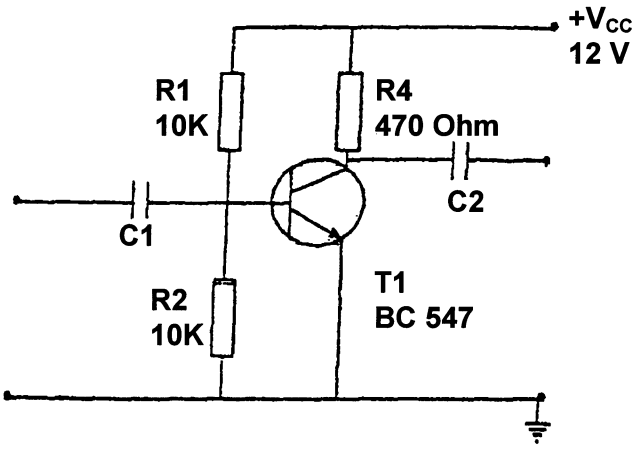


Figure 6.1

6.1.1 Name the coupling method used in the amplifier in **Figure 6.1**. (2)

6.2 In a neatly labelled sketch, illustrate Class B amplification by using input and output wave forms projected onto the emitter output curve. (5)

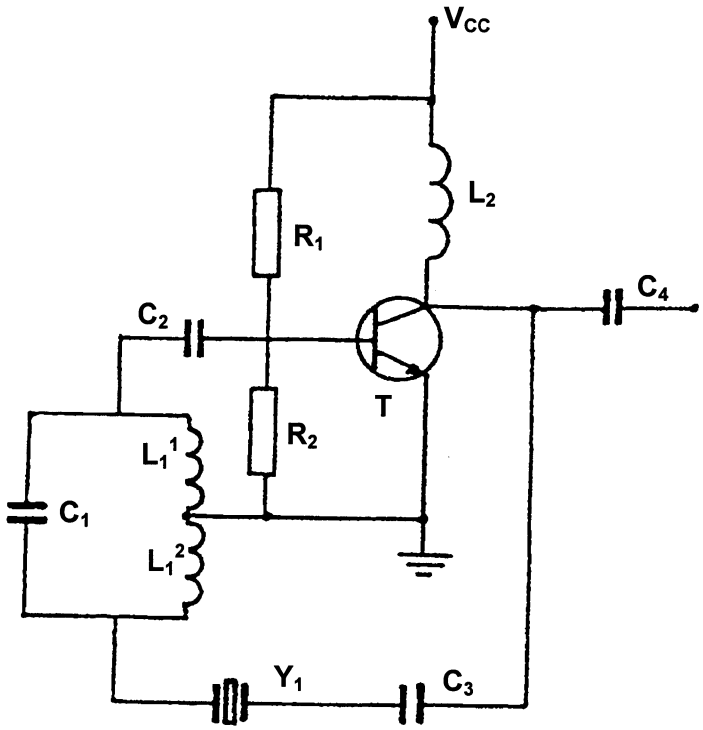
6.3 Bepaal die laslyn van die versterker in **Figuur 6.3** en skets die benoemde laslyn in jou antwoordboek. (9)



Figuur 6.3

6.4 Skets 'n netjies benoemde frekwensiekurwe van 'n resistorkapasitor-gekoppelde versterker. (4)
[20]

VRAAG 7
OSSILATORS



Figuur 7.1

6.3 Determine the loadline of the amplifier in **Figure 6.3** and sketch the labelled loadline in your answer book. (9)

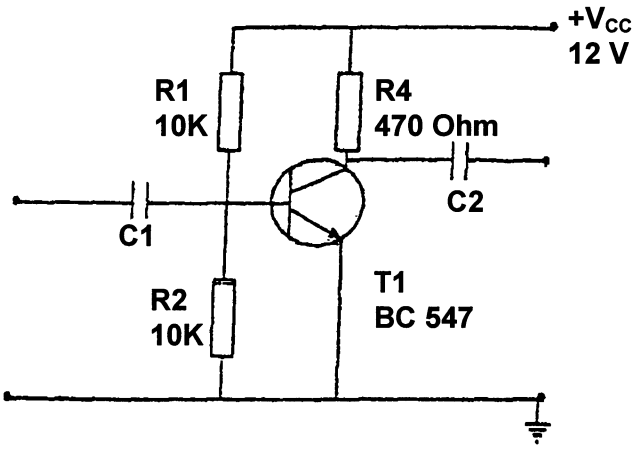


Figure 6.3

6.4 Sketch a neatly labelled frequency curve of a resistor-capacitor-coupled amplifier. (4)
[20]

QUESTION 7
OSCILLATORS

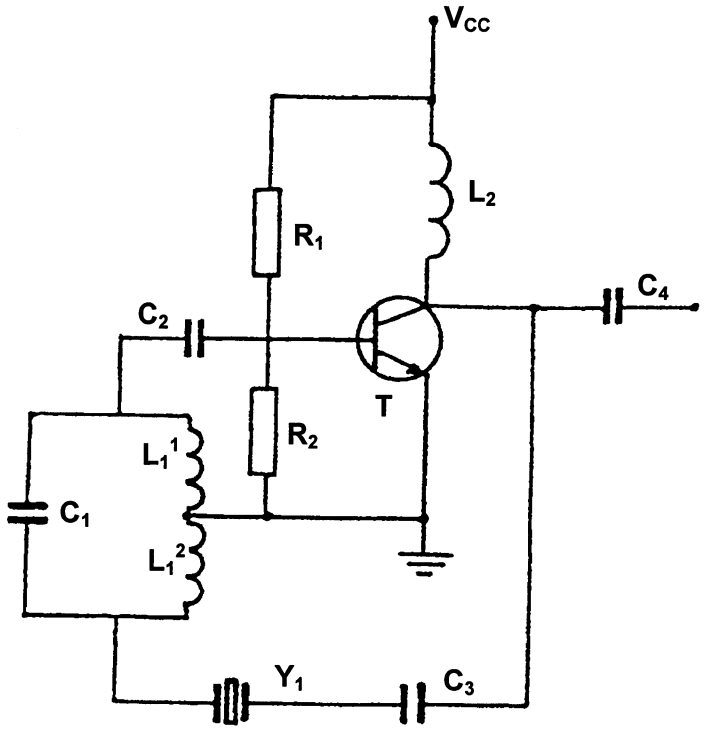


Figure 7.1

7.1 Identifiseer die kring wat in **Figuur 7.1** geillustreer word. (2)

7.2 Beskryf die funksie van **R1** en **R2** in die kring. (4)

7.3 Identifiseer die komponente wat die tenkkring vorm. (2)

7.4 Identifiseer **Y1**. (2)

7.5 Verduidelik kortliks hoe die waarde van **Y1** geselekteer word. (2)

7.6 Gee TWEE redes waarom die afvoerfrekwensie van die kring in **Figuur 7.1** nie stabiel sal wees sonder **Y1** nie. (4)

7.7 Wat is die doel van die positiewe terugvoer by ossilatorkringbane? (2)

7.8 Gee 'n tipiese uitsetkurwe van 'n ossilator soos in **Figuur 7.1** getoon word. (2)
[20]

VRAAG 8
OPERASIONELE VERSTERKERS

8.1 Teken 'n kringdiagram van 'n vergelyker wat van 'n operasionele versterker gebruik maak. Skets tipiese afvoergolfvorms indien die invoer sinusvormig is. (6)

8.2 Die differensiaalversterker is die bousteen van die operasionele versterker. Bespreek hierdie stelling met behulp van 'n kringdiagram en verduidelik kortliks wat met die uitset gebeur as daar 'n klein verandering op die insette plaasvind. (9)
[15]

7.1 Identify the circuit illustrated in **Figure 7.1**. (2)

7.2 Describe the function of **R1** and **R2** in the circuit. (4)

7.3 Identify the components which form the tank circuit. (2)

7.4 Identify **Y1**. (2)

7.5 Briefly describe how the value of **Y1** is selected. (2)

7.6 Give TWO reasons why the output frequency of the circuit in **Figure 7.1**, without **Y1**, would not remain stable. (4)

7.7 What is the purpose of positive feedback in oscillating circuits? (2)

7.8 Give a typical output curve of an oscillator as shown in **Figure 7.1**. (2)
[20]

QUESTION 8
OPERATIONAL AMPLIFIERS

8.1 Draw a circuit diagram of a comparator using an operational amplifier. Sketch typical output wave forms if the input is sinusoidal. (6)

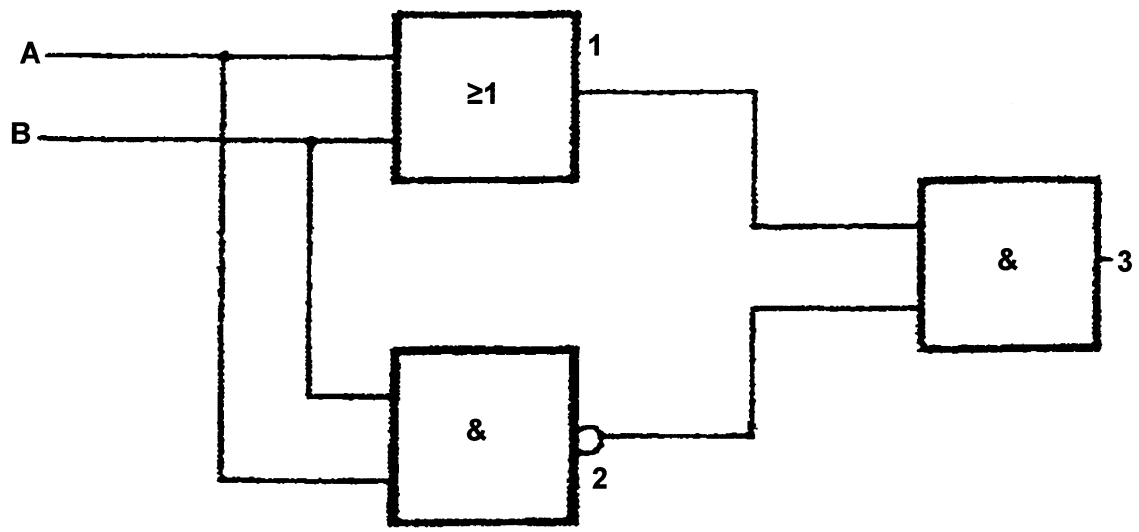
8.2 The differential amplifier is the building block of an operational amplifier. Describe this theory by using a circuit diagram and explain what happens to the output when a small change occurs on the inputs. (9)
[15]

VRAAG 9
REKENAARBEGINSELS

9.1 Skets die simbool en gee die waarheidstabel van 'n hek met die volgende Boole-vergelyking:

$\overline{A+B}$ (4)

9.2



Figuur 9

9.2.1 Toon die Boole-vergelykings vir uitsette **1**, **2** en **3**. (4)

9.2.2 Watter enkellogikahek sal dieselfde funksie as die kring in Vraag 9.2 verrig? (2)

9.3 Gee die naam, simbool en waarheidstabel vir TWEE logikahekke wat nie in Vraag 9.1 en Vraag 9.2 gebruik is nie. (8)

9.4 Drie persone het elk 'n sleutel van die brandkluis by die skool, naamlik die hoof en die twee adjunkhoofde. Ten minste twee persone moet teenwoordig wees voordat die kluis oopgesluit kan word. Een van die persone moet egter die hoof wees.

Gestel A = hoof, B en C = Adjunkhoofde

9.4.1 Stel 'n waarheidstabel op om bogenoemde funksie te vervul. (3)

9.4.2 Verskaf die Boole-vergelyking om die funksie hierbo, voor te stel. (2)

9.4.3 Vereenvoudig die Boole-vergelyking en noem die reël wat in hierdie berekening toegepas is. (4)

9.4.4 Teken 'n logiese kringbaan om die funksie in Vraag 9.4.3 te vervul. (3)

9.5 Teken 'n kringdiagram van 'n geklokte RS-grendel deur gebruik te maak van net twee NEN-hekke. (5)

[35]

QUESTION 9
COMPUTER PRINCIPLES

9.1 Sketch the symbol and give the truth table of a gate with the following Boolean equation:

$\overline{A+B}$ (4)

9.2

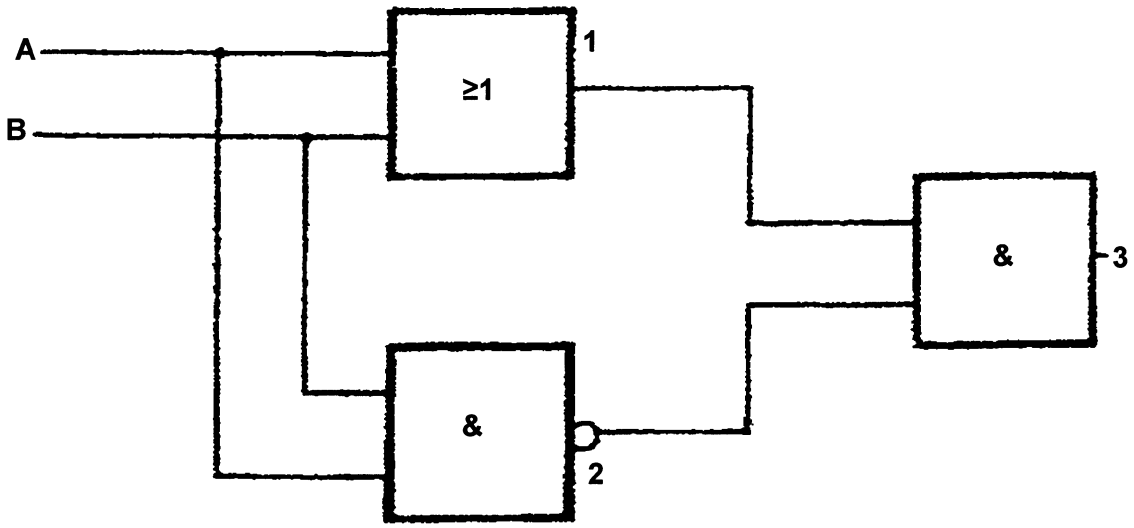


Figure 9

9.2.1 State the Boolean equations for outputs **1**, **2** and **3**. (4)

9.2.2 Which single logic gate will perform the same function as the circuit in Question 9.2? (2)

9.3 Give the name, symbol and truth table for TWO logic gates not used in Questions 9.1 and 9.2. (8)

9.4 Three persons each have a key to the safe at the school, namely the principal and the two deputy principals. At least two persons must be present before the safe is opened. One person must, however, be the principal.

A = principal, B and C = deputy principals

9.4.1 Draw up a truth table to perform the above function. (3)

9.4.2 Give the Boolean equation to represent the above function. (2)

9.4.3 Simplify the Boolean equation and name the rule that is used in this calculation. (4)

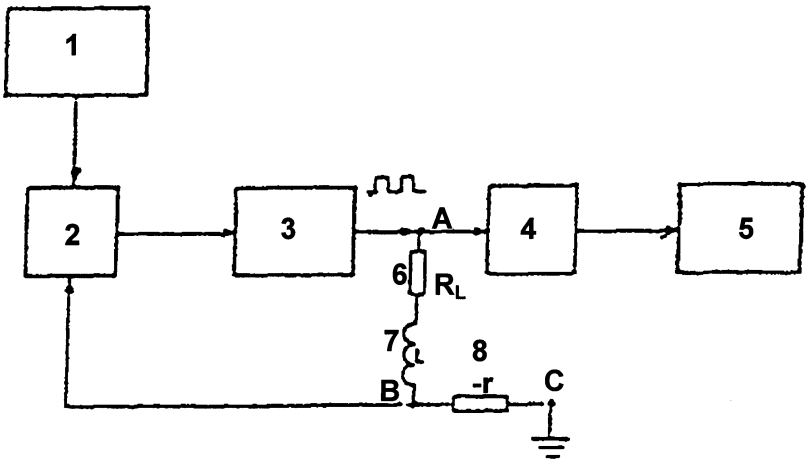
9.4.4 Draw a logic circuit to perform the function in Question 9.4.3. (3)

9.5 Draw a circuit diagram of a clocked RS latch by using only two NAND gates. (5)

[35]

VRAAG 10
MEETINSTRUMENTE

10.1 Benoem die blokdiagram van die induktansiemeter in **Figuur 10**.



Figuur 10 (8)

10.2 Noem TWEE gebruike van 'n ossiloskoop. (2)
[10]

VRAAG 11
BEROEPSVEILIGHEID

11.1 Nadat jy as veiligheidsinspekteur by 'n maatskappy aangestel is, is jou eerste opdrag om 'n veiligheidsplakkaat te maak om jou medewerkers van onveilige toestande bewus te maak.

Noem enige VYF veiligheidsmaatreëls wat jy in ag sal neem wanneer jy so 'n plakkaat saamstel. **[10]**

TOTAAL: 300

QUESTION 19
MEASURING INSTRUMENTS

10.1 Label the block diagram of the inductance meter given in **Figure 10**.

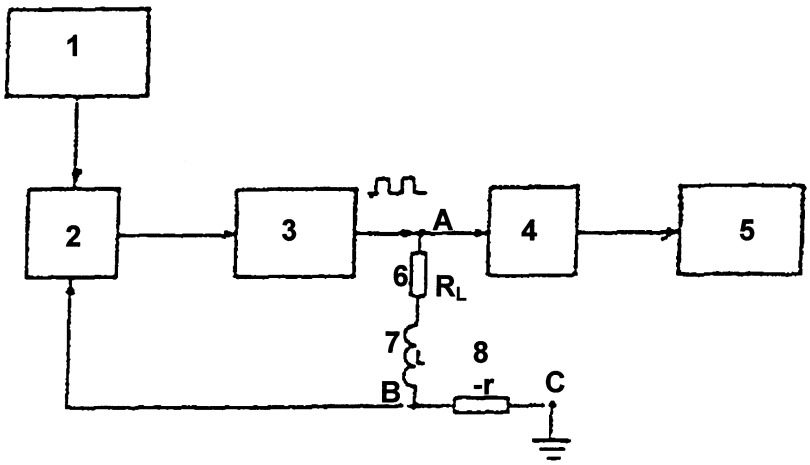


Figure 10 (8)

10.2 List TWO uses of an oscilloscope. (2)

[10]

QUESTION 11
OCCUPATIONAL SAFETY

11.1 After you have been appointed as a safety inspector at a firm, your first instruction is to make a safety poster to inform your co-workers of unsafe conditions.

List any FIVE important safety rules that should be considered when designing such a poster. **[10]**

TOTAL: 300

FORMULAE / *FORMULES*

$X_L = 2\pi LF$

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

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

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

$I_C = V.\sqrt{\frac{C}{L}}$

$f = \frac{W}{2\pi}$

$t = R.C$

Star / *Ster*

$V_L = V_P.\sqrt{3}$

$I_L = I_P$

$Ir = I \sin\theta$

$P = \sqrt{3}.V_L.I_L.\cos\theta$

$\cos\theta = \frac{P}{P_{\text{apparent / skynbaar}}}$

Efficiency / *Rendement* $= \frac{\text{Output/ Uitset}}{\text{Input/ Inset}}$

$N_S = \frac{f}{P}$

$\frac{N_P}{N_S} = \sqrt{\frac{Z_P}{Z_S}}$

$\beta = \frac{I_C}{I_B}$

$V_R = IR$

$V_L = LX_L$

$V_C = I.X_C$

$Q = \frac{X_L}{R}$

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

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

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

$Z = \frac{L}{C.R}$

Delta

$I_L = I_P.\sqrt{3}$

$V_L = V_P$

$Ia = I \cos\theta$

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

$N_r = N_S - S$

$S = \frac{N_S - N_r}{N_S}$

$I_E = I_B + I_C$

$I_C = \frac{V_{CC}}{R_L}$

$N = 10 \text{Log} \frac{P_2}{P_1}$

END / *EINDE*