



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NASIONALE SENIOR SERTIFIKAAT

GRAAD 12

ELTT.1

ELEKTRIESE TEGNOLOGIE

FEBRUARIE/MAART 2017

PUNTE: 200

TYD: 3 uur

Hierdie vraestel bestaan uit 13 bladsye en 'n 2 bladsy-formuleblad.

MIDDAGSESSIE

INSTRUKSIES EN INLIGTING

1. Hierdie vraestel bestaan uit SEWE vrae.
2. Beantwoord AL die vrae.
3. Sketse en diagramme moet groot, netjies en volledig benoem wees.
4. Toon ALLE berekeninge en rond antwoorde korrek tot TWEE desimale plekke af.
5. Nommer die antwoorde korrek volgens die nommeringstelsel wat in hierdie vraestel gebruik is.
6. Jy mag 'n nieprogrammeerbare sakrekenaar gebruik.
7. Toon die eenhede vir alle antwoorde van berekeninge.
8. 'n Formuleblad is aan die einde van hierdie vraestel aangeheg.
9. Skryf netjies en leesbaar.

VRAAG 1: BEROEPSGESONDHEID EN VEILIGHEID

- 1.1 Noem TWEE onveilige handelinge wat tot 'n ongeluk kan lei. (2)
- 1.2 Onderskei tussen 'n *onveilige handeling* en 'n *onveilige toestand*. (2)
- 1.3 Noem VIER punte in die prosedure wat gevvolg moet word wanneer 'n persoon besig is om 'n elektriese skok te ervaar. (4)
- 1.4 Verduidelik waarom 'n persoon onder die invloed van drank nie masjinerie in die werksplek mag hanteer nie. (2)
- [10]**

VRAAG 2: DRIEFASE-WS-OPWEKKING

- 2.1 Definieer die volgende begrippe:
- 2.1.1 Aktiewe drywing (2)
- 2.1.2 Reaktiewe drywing (2)
- 2.2 Teken 'n netjiese, benoemde diagram wat die golfvorme van 'n driefase-WS-ontwikkelde stelsel voorstel. (5)
- 2.3 'n Gebalanseerde driefase- induktiewe las word in delta oor 'n driefasetoevoer verbind. Die las trek 'n stroom van 30 A vanaf die 380 V/50 Hz-toevoer. Dit het 'n arbeidsfaktor van 0,75 nalopend.

Gegee:

$$\begin{aligned} I_L &= 30 \text{ A} \\ V_L &= 380 \text{ V} \\ \text{af.} &= 0,75 \text{ nalopend} \end{aligned}$$

Bereken die:

- 2.3.1 Fasestroom (3)
- 2.3.2 Impedansie van die las (3)
- 2.3.3 Noem wat met die stroom sal gebeur wat deur die las getrek word indien die arbeidsfaktor van die las verbeter word. (1)
- 2.3.4 Noem EEN ekonomiese voordeel van die verbetering van die arbeidsfaktor. (1)

- 2.4 Die tweewattmetermetode word gebruik om die drywing te meet wat deur 'n induksiemotor getrek word. Die lesings op die wattmeters is 100 W en 250 W onderskeidelik. Bereken die totale insetdrywing.

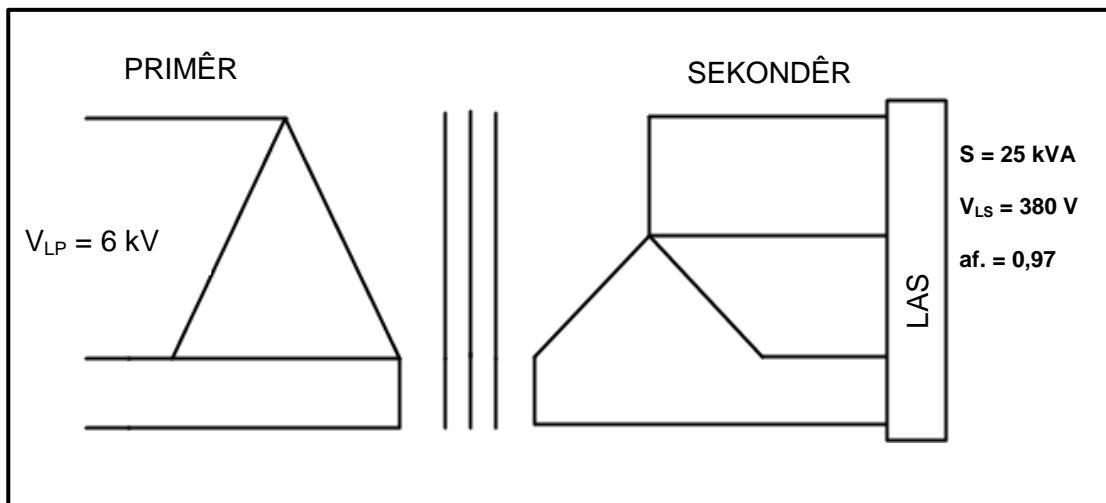
Gegee:

$$\begin{aligned} P_1 &= 100 \text{ W} \\ P_2 &= 250 \text{ W} \end{aligned} \quad (3)$$

[20]

VRAAG 3: DRIEFASETTRANSFORMATORS

- 3.1 Noem die doel van 'n transformator. (1)
- 3.2 Noem TWEE verkoelingsmetodes wat in 'n transformator gebruik word. (2)
- 3.3 Noem waar 'n delta-stertransformatorverbinding gebruik word. (1)
- 3.4 FIGUUR 3.1 hieronder stel die delta-sterverbinding van 'n driefase-transformator voor.

**FIGUUR 3.1: DRIEFASETTRANSFORMATOR**

Gegee:

$$\begin{aligned} S &= 25 \text{ kVA} \\ V_{LP} &= 6 \text{ kV} \\ V_{LS} &= 380 \text{ V} \\ \text{af.} &= 0,97 \text{ naloopend} \end{aligned}$$

Bereken die:

- 3.4.1 Sekondêre lynstroom (3)
- 3.4.2 Primêre lynstroom (3)
- 3.4.3 Primêre fasestroom (3)
- 3.4.4 Transformasieverhouding (3)
- 3.5 Verduidelik waarom die sekondêre winding van 'n verspreidingstransformator in ster verbind word. (2)
- 3.6 Noem waarom gereelde instandhouding van transformators belangrik is. (2)
[20]

VRAAG 4: DRIEFASEMOTORS EN -AANSITTERS

- 4.1 Noem EEN voordeel van 'n driefase-induksiemotor bo 'n enkelfase-induksiemotor. (1)
- 4.2 Beskryf waarom dit belangrik is dat die rotor van 'n motor vrylik draai voordat dit bekrag word. (2)
- 4.3 Noem TWEE elektriese toetse wat op 'n motor uitgevoer moet word voordat dit bekrag word. (2)
- 4.4 Beskryf EEN toestand wat kan bestaan indien daar 'n elektriese verbinding tussen die rotor en die stator van 'n driefase-induksiemotor is. (2)
- 4.5 Noem TWEE verliese wat in 'n driefasemotor plaasvind. (2)
- 4.6 'n Driefase- deltaverbinde motor, met 'n aanslag van 15 kVA, word aan 'n 380 V/50 Hz-toevoer verbind. Die motor het 'n arbeidsfaktor van 0,8 en 'n rendement van 95%.

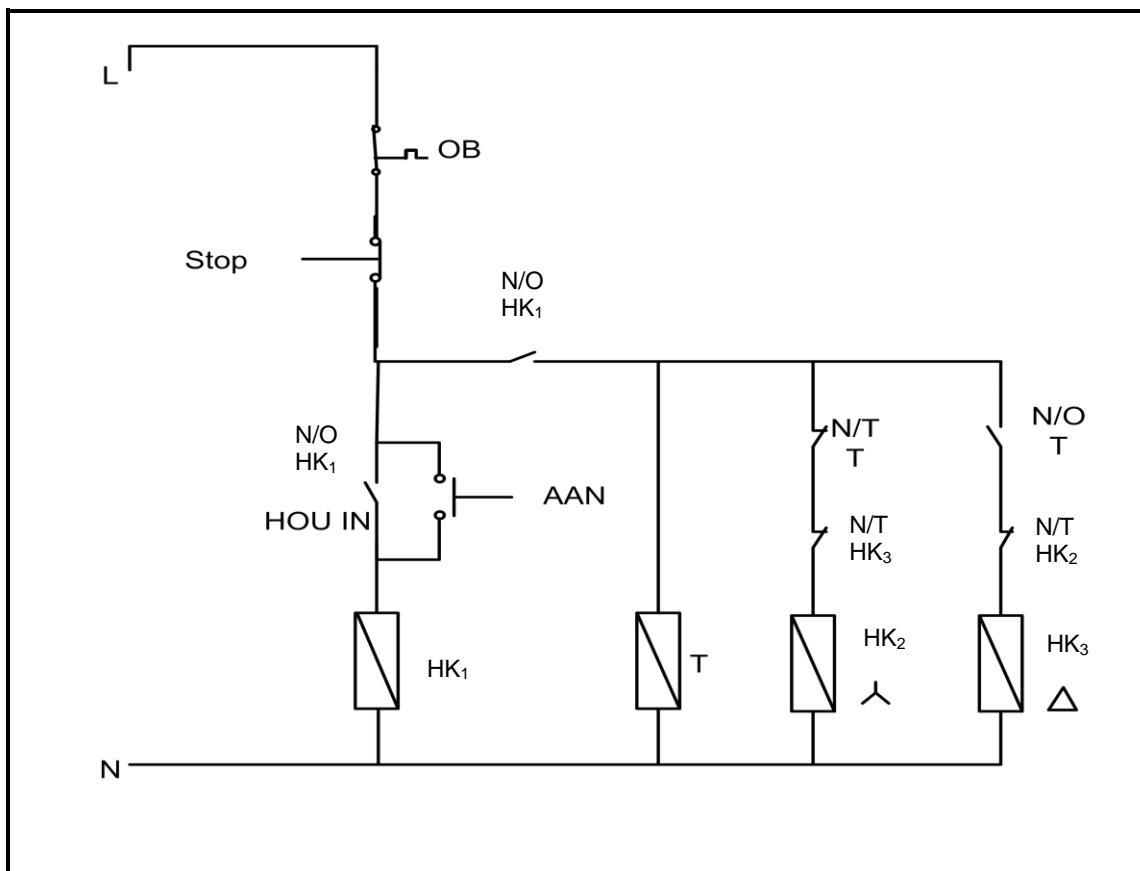
Gegee:

$$\begin{aligned}V_L &= 380 \text{ V} \\S &= 15 \text{ kVA} \\f &= 50 \text{ Hz} \\af. &= 0,8 \\\eta &= 95\%\end{aligned}$$

Bereken die:

- 4.6.1 Uitsetdrywing van die motor teen volgas as die rendement van die motor 100% is (3)
- 4.6.2 Uitsetdrywing van die motor teen volgas teen 95% rendement (3)
- 4.6.3 Die stroom deur die motor getrek (3)
- 4.7 Beantwoord die volgende vrae met verwysing na 'n driefase-induksiemotor.
- 4.7.1 Noem wat met die uitsetkrag van die motor sal gebeur indien die rendement van die motor verbeter word. (1)
- 4.7.2 Beskryf wat met die reaktiewe drywing van die motor sal gebeur as die arbeidsfaktor van die motor verbeter word. Struktureer jou antwoord met verwysing na spanning, stroom en drywing. (3)

4.8 FIGUUR 4.1 hieronder stel die beheerkring van 'n ster-delta-aansitter voor.

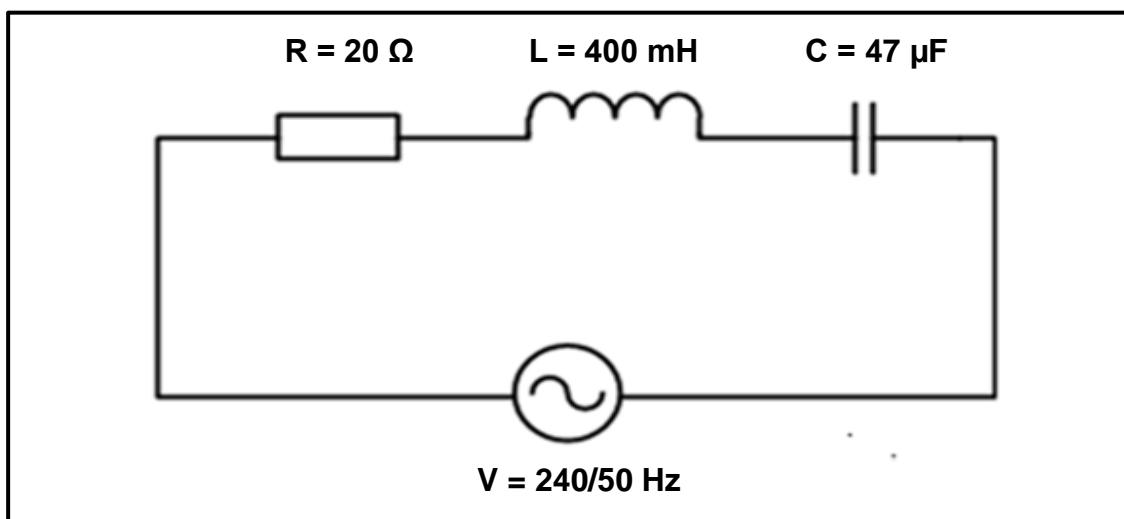


FIGUUR 4.1: BEHEERKRING VAN 'N STER-DELTA-AANSITTER

- 4.8.1 Beskryf hoe 'n ster-delta-aansitter die aansitstroom van die motor beperk/verminder. (3)
- 4.8.2 Noem waarom dit nodig is om die aansitstroom van 'n driefase-induksiemotor te beperk. (3)
- 4.8.3 Beskryf die funksie van die oorbelastingseenheid in die aansitter. (3)
- 4.8.4 Beskryf die grendeling wat in die kring gebruik word om te voorkom dat die motor in delta geskakel word, terwyl dit steeds in ster verbind is. (5)
- 4.9 Beskryf waarom induksietipe motors van 'n konstante frekwensie voorsien moet word. (3)
- 4.10 Noem hoe die aantal poolpare van 'n induksiemotor die spoed van 'n motor beïnvloed. (1)
[40]

VRAAG 5: RLC

- 5.1 Noem TWEE faktore wat die reaktansiewaarde van 'n spoel beïnvloed wanneer dit oor 'n WS-toevoer gekoppel is. (2)
- 5.2 Noem hoe 'n toename in kapasitansie die reaktansie van 'n kapasitor sal beïnvloed. (1)
- 5.3 Verduidelik die term *resonansie* met verwysing na 'n RLC-kring. (3)
- 5.4 Verwys na die diagram in FIGUUR 5.1 hieronder.

**FIGUUR 5.1: RLC-SERIEKRING**

Gegee:

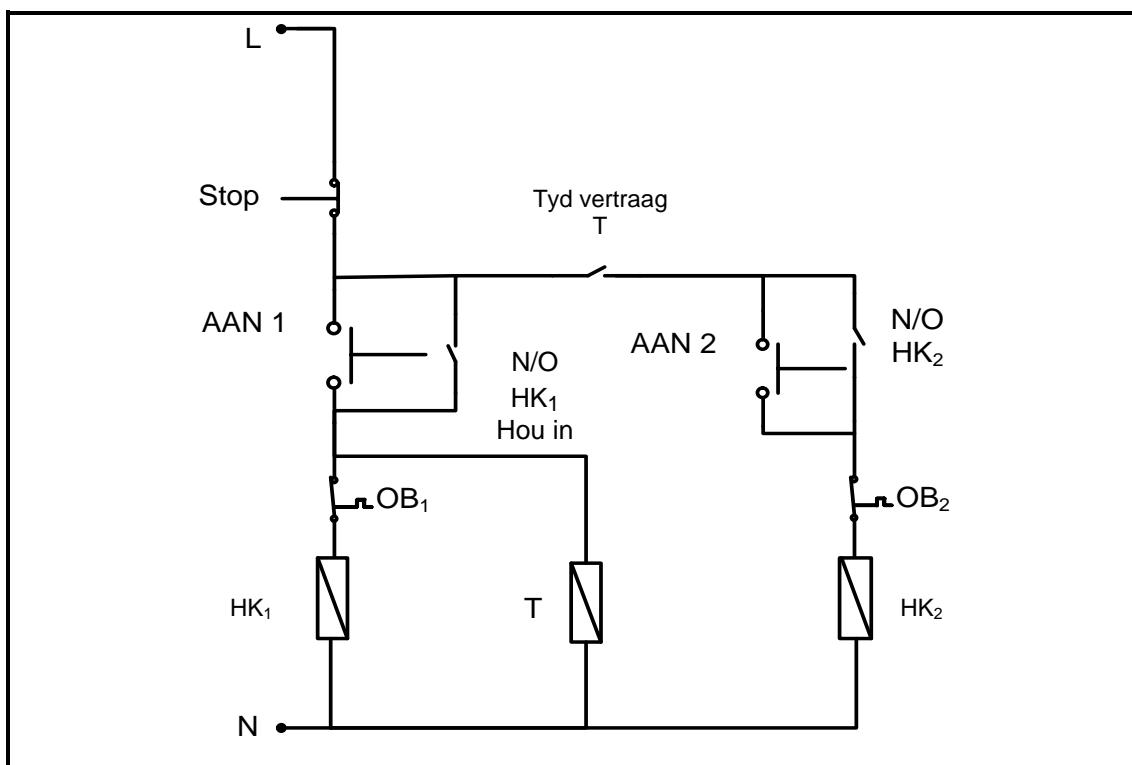
$$\begin{aligned} R &= 20 \Omega \\ L &= 400 \text{ mH} \\ C &= 47 \mu\text{F} \\ V &= 240 \text{ V} \\ f &= 50 \text{ Hz} \end{aligned}$$

Bereken die:

- 5.4.1 Induktiewe reaktansie van die induktor (3)
- 5.4.2 Kapasitiewe reaktansie van die kapasitor (3)
- 5.4.3 Impedansie van die kring (3)
- 5.4.4 Q-faktor van die kring wanneer die kring by resonansie is (3)
- 5.5 Noem, met 'n rede, of die kring in FIGUUR 5.1 oorwegend induktief of oorwegend kapasitief is. (2)
- [20]

VRAAG 6: LOGIKA

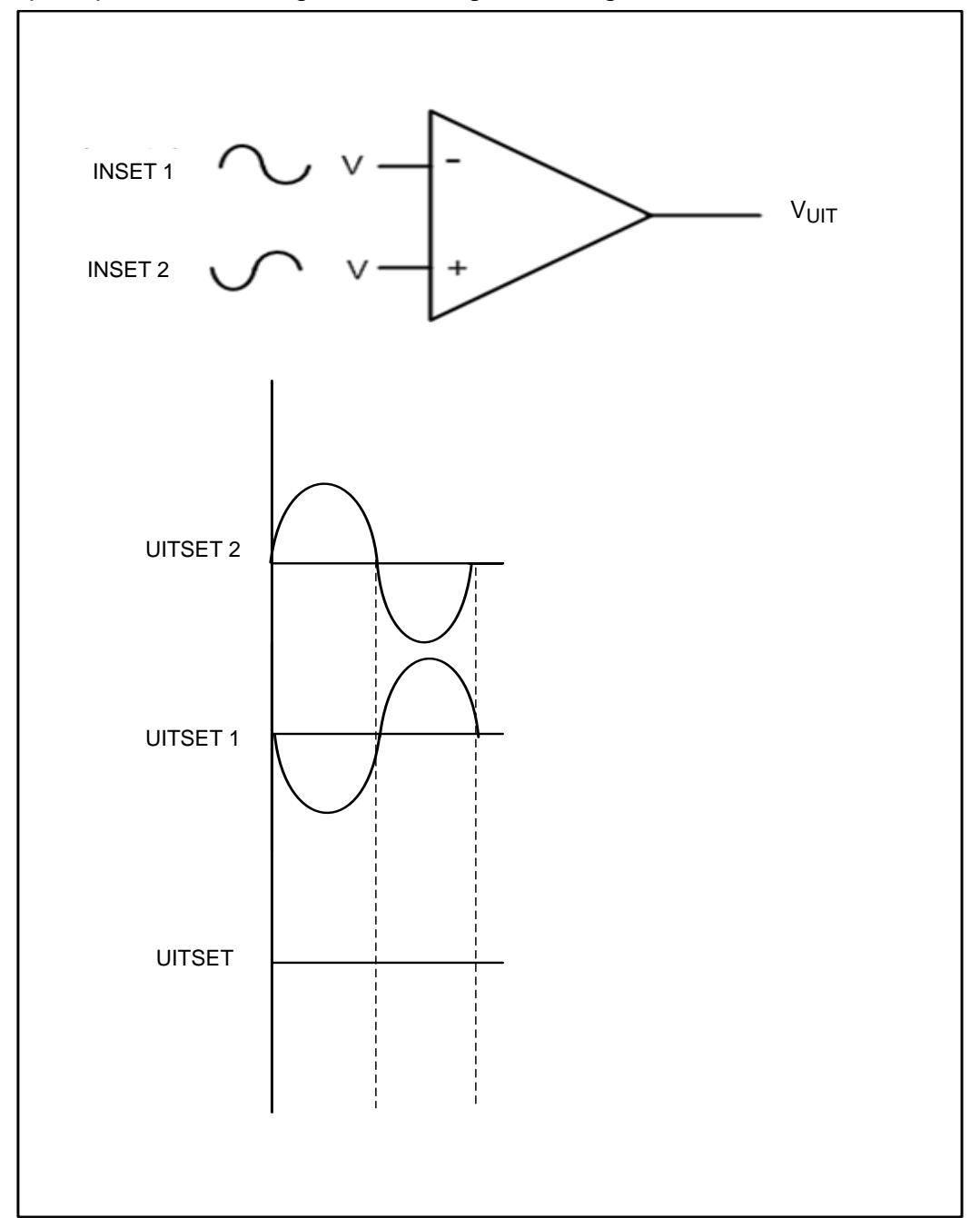
- 6.1 Beantwoord die volgende vrae ten opsigte van PLB's.
- 6.1.1 Skryf die afkorting *PLB* volledig uit. (1)
 - 6.1.2 Noem TWEE voordele van 'n PLB-stelsel bo relêlogika. (2)
 - 6.1.3 Noem TWEE insettoestelle wat aan 'n PLB verbind kan word. (2)
 - 6.1.4 Noem EEN komponent wat steeds gebruik word om hoëstroomtoestelle aan en af te skakel. (1)
 - 6.1.5 Definieer die term *program* ten opsigte van 'n PLB. (3)
 - 6.1.6 Noem EEN toestel wat 'n PLB oor 'n afstand kan beheer. (1)
 - 6.1.7 Teken 'n blokdiagram om die komponente van 'n PLB-stelsel te illustreer. (5)
- 6.2 Vereenvoudig die volgende uitdrukking met Boole-algebra:
- $$X = \bar{D}EF + \bar{D}\bar{E}F + D\bar{E}F + D\bar{E}\bar{F}$$
- (6)
- 6.3 Teken 'n drie-veranderlike-Karnaugh-kaart en vereenvoudig die volgende Boole-uitdrukking:
- $$X = \bar{A}BC + \bar{A}B\bar{C} + A\bar{B}C$$
- (8)
- 6.4 Verwys na die kring in FIGUUR 6.1 hieronder.

**FIGUUR 6.1: SEKWENSIËLE AANSITTER MET 'N TYDREËLAAR**

- 6.4.1 Teken die leerlogikadiagram wat dieselfde funksie in 'n PLB-stelsel sal uitvoer. (10)
- 6.4.2 Noem EEN elektriese toepassing van FIGUUR 6.1. (1)
[40]

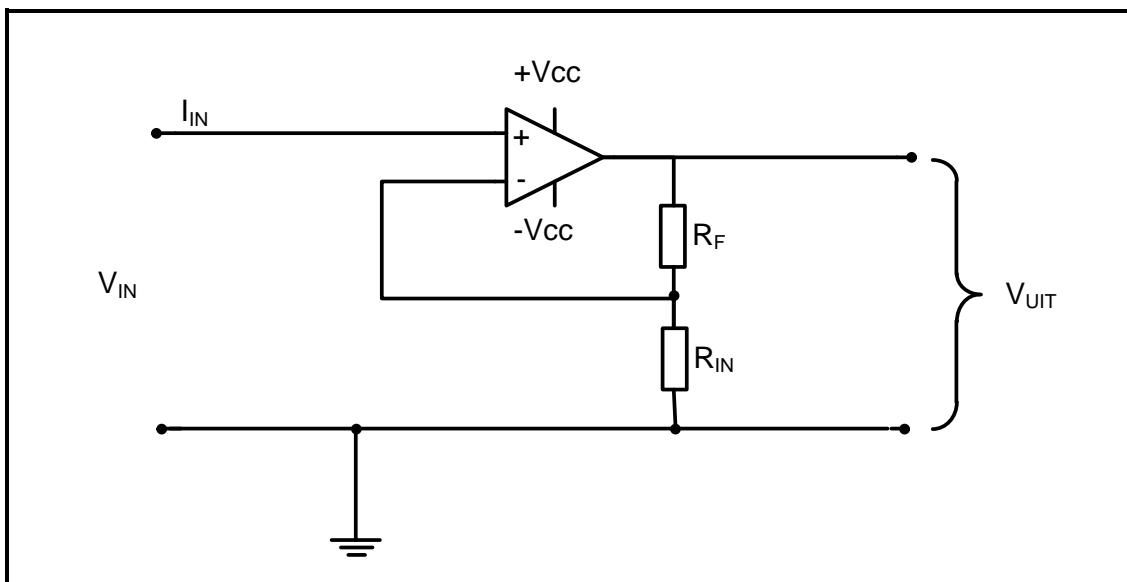
VRAAG 7: VERSTERKERS

- 7.1 Teken en benoem die simbool van 'n operasionele versterker (op-amp). (5)
- 7.2 Noem DRIE kenmerke van 'n ideale op-amp. (3)
- 7.3 Beskryf waarom op-ampkringe in 'n geïntegreerde stroombaan (IC)-pakket verpak word. (2)
- 7.4 Beskryf wat die term *negatiewe terugvoer* ten opsigte van 'n op-amp beteken. (3)
- 7.5 Noem TWEE voordele van negatiewe terugvoer. (2)
- 7.6 Verwys na FIGUUR 7.1 hieronder en teken die uitset van 'n ideale op-amp met betrekking tot die insetgolfvorme getoon.

**FIGUUR 7.1: OP-AMP**

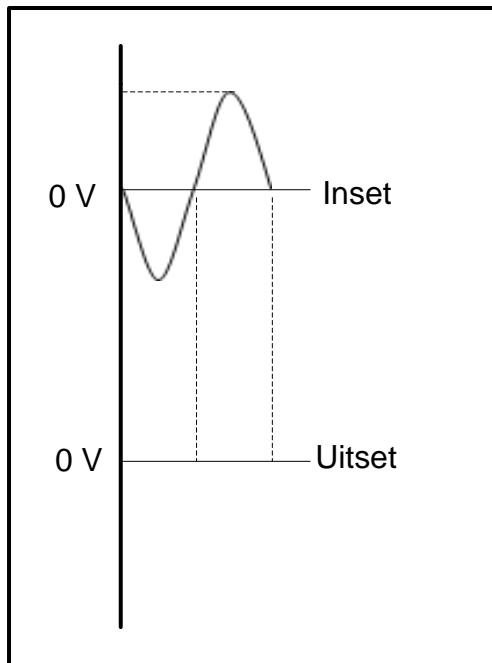
(3)

7.7 Verwys na FIGUUR 7.2 hieronder en beantwoord die vrae wat volg.



FIGUUR 7.2: NIE-OMKEER-OP-VERSTERKERKRING

7.7.1 Teken die inset- en uitsetgolfvorms op dieselfde Y-as, soos in FIGUUR 7.3 hieronder getoon.



FIGUUR 7.3: UITSETGOLFVORM

(3)

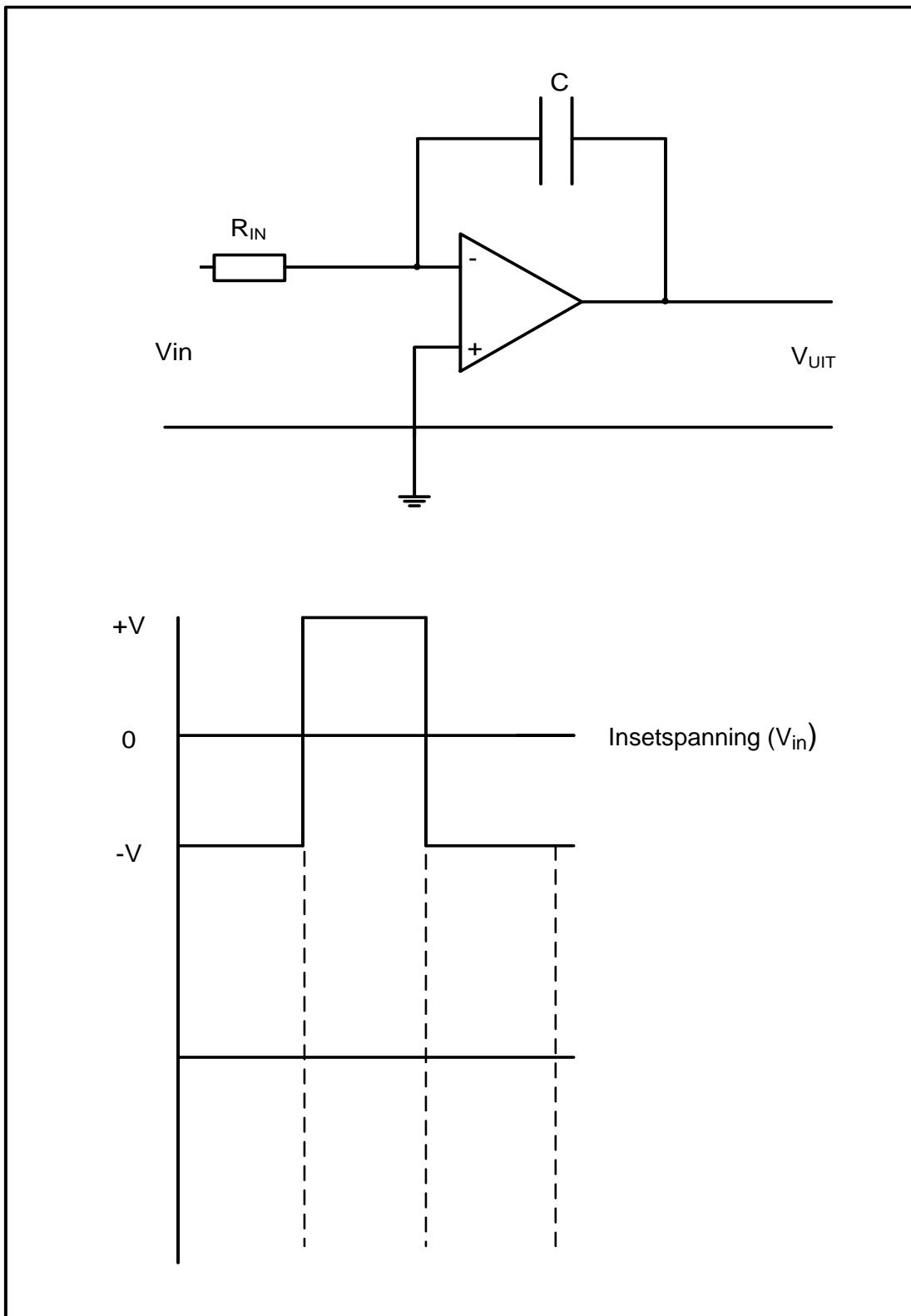
- 7.7.2 Bereken die spanningswins indien die terugvoerweerstand $12\text{ k}\Omega$ is en die insetweerstand 'n waarde van $3,3\text{ k}\Omega$ het.

Gegee:

$$\begin{aligned}R_F &= 12\text{ k}\Omega \\R_{IN} &= 3,3\text{ k}\Omega \\V_{IN} &= 6\text{ V}\end{aligned}\tag{3}$$

- 7.7.3 Bereken die uitsetspanning indien 'n insetsein van 6 V op die op-amp toegepas word.
(3)
- 7.7.4 Beskryf wat met die wins van die op-amp gebeur indien die waarde van R_F verlaag word.
(2)

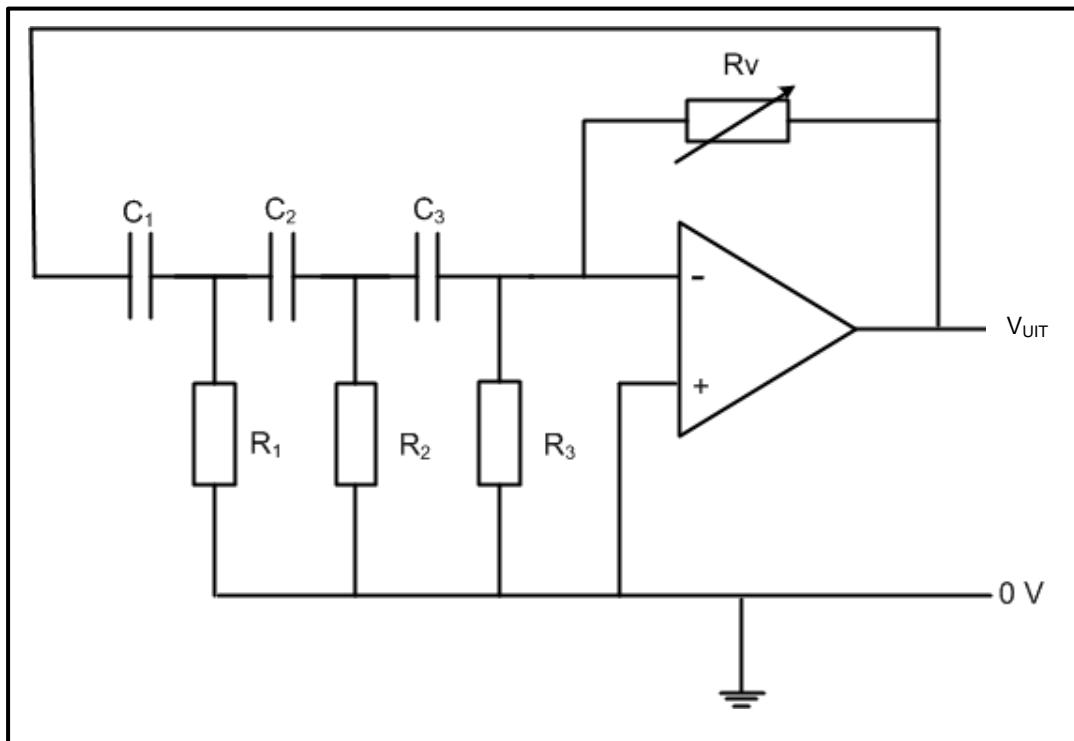
7.8 Verwys na FIGUUR 7.4 hieronder en beantwoord die vrae wat volg.



FIGUUR 7.4: INTEGREERDER-OP-AMPKRING

- 7.8.1 Teken en benoem die gegewe insetgolfvorm en, in lyn daarmee, die uitsetgolfvorm direk daaronder. (6)
- 7.8.2 Beskryf die funksie van die kapasitor in hierdie op-ampkring. (3)

7.9 Verwys na FIGUUR 7.5 hieronder en beantwoord die vrae wat volg.



FIGUUR 7.5: RC-FASESKUIF-OSSILLATORKRING

Gegee:

$$\begin{array}{llll} R_1 & = & R_2 & = \\ C_1 & = & C_2 & = \end{array} \quad \begin{array}{lll} R_3 & = & 12 \text{ k}\Omega \\ C_3 & = & 260 \text{ nF} \end{array}$$

- 7.9.1 Noem TWEE toepassings van die ossillator. (2)
- 7.9.2 Bereken die ossilleerfrekwensie van die ossillator. (3)
- 7.9.3 Identifiseer die uitsetgolfvorm van die ossillator. (1)
- 7.9.4 Noem die tipe terugvoer wat in hierdie ossillator gebruik is. (1)
- 7.10 Beskryf die funksie van die dubbele GS-toevoer na 'n op-amp. (3)
- 7.11 Noem die uitsetgolfvorm van 'n differensieerkring wanneer 'n driehoekige insetgolf toegepas word. (1)
- 7.12 Noem EEN toepassing van 'n differensieerder. (1)
[50]

TOTAAL: 200

FORMULEBLAD

DRIEFASE-WS-OPWEKKING	RLC-KRINGE
Ster	$X_L = 2\pi fL$ $X_C = \frac{1}{2\pi fC}$ $F_R = \frac{1}{2\pi\sqrt{LC}}$
$V_L = \sqrt{3} V_F$	
$I_L = I_F$	
Delta	Serie
$V_L = V_F$	$I_T = I_R = I_C = I_L$
$I_L = \sqrt{3} I_F$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
$S = \sqrt{3} V_L I_L$	$V_L = I X_L$
$Q = \sqrt{3} V_L I_L \sin \theta$	$V_C = I X_C$
$\cos \theta = \frac{P}{S}$	$V_T = I Z$
$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times \eta$	$V_T = \sqrt{V_R^2 + (V_L - V_C)^2}$
$V_P = I_P \times Z_P$	$I_T = \frac{V_T}{Z}$
Tweewattmetermetode	$\cos \theta = \frac{R}{Z}$
$P = P_1 + P_2$	$\cos \theta = \frac{V_R}{V_T}$
	$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{V_C}{V_S} = \frac{1}{R} \sqrt{\frac{L}{C}}$
DRIEFASETTRANSFORMATORS	
Ster	Parallel
$V_L = \sqrt{3} V_F$	$V_T = V_R = V_C = V_L$
$I_L = I_F$	$I_R = \frac{V_R}{R}$
Delta	$I_C = \frac{V_C}{X_C}$
$I_L = \sqrt{3} I_F$	$I_L = \frac{V_L}{X_L}$
$V_L = V_F$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$
$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times \eta$	$\cos \theta = \frac{I_R}{I_T}$
$S = \sqrt{3} V_L I_L$	$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{V_C}{V_S} = \frac{1}{R} \sqrt{\frac{L}{C}}$

$Q = \sqrt{3} V_L I_L \sin \theta$ $\cos \theta = \frac{P}{S}$ $\frac{V_{F(P)}}{V_{F(S)}} = \frac{N_P}{N_S} = \frac{I_{F(S)}}{I_{F(P)}}$	
DRIEFASEMOTORS EN -AANSITTERS Ster $V_L = \sqrt{3} V_F$ $I_L = I_F$	VERSTERKERS $Wins A_v = \frac{V_{UIT}}{V_{IN}} = -\left(\frac{R_F}{R_{IN}} \right)$ $Wins A_v = \frac{V_{UIT}}{V_{IN}} = 1 + \frac{R_F}{R_{IN}}$ $f_R = \frac{1}{2\pi\sqrt{LC}}$ $f_R = \frac{1}{2\pi\sqrt{6RC}}$
Delta $I_L = \sqrt{3} I_F$ $V_L = V_F$	$T = 5RC$ $V_{UIT} = -(V_1 + V_2 + V_3 + \dots + V_N)$
Drywing $P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times \eta$ $S = \sqrt{3} V_L I_L$ $Q = \sqrt{3} V_L I_L \sin \theta$ $Rendement(\eta) = \frac{P_{IN} - verliese}{P_{IN}}$	



<p>THREE-PHASE MOTORS AND AMPLIFIERS</p> <p>$Q = \sqrt{3} V_L I_L \sin \theta$</p> <p>$\cos \theta = \frac{P}{S}$</p> <p>$V_{PH(P)} = \frac{S}{N_p} = \frac{V_{PH(S)}}{I_{PH(S)}}$</p> <p>STARTERS</p> <p>$I_L = I_{PH}$</p> <p>$V_L = \sqrt{3} V_{PH}$</p> <p>$Gain A_V = \frac{V_{out}}{V_{in}} = -\left(\frac{R_f}{R_{in}}\right)$</p> <p>$Gain A_V = \frac{V_{out}}{V_{in}} = \frac{V_{in}}{R_{in}} \left(1 + \frac{R_f}{R_{in}}\right)$</p> <p>$f_R = \frac{1}{2\pi\sqrt{LC}}$</p> <p>$T = 5RC$</p> <p>$V_{out} = -(V_1 + V_2 + V_3 + \dots + V_N)$</p> <p>$I_L = \sqrt{3} I_{PH}$</p> <p>$V_L = V_{PH}$</p> <p>Delta</p> <p>$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times \eta$</p> <p>$S = \sqrt{3} V_L I_L$</p> <p>$Q = \sqrt{3} V_L I_L \sin \theta$</p> <p>$Efficiency (\eta) = \frac{P_{in} - losses}{P_{in}}$</p> <p>Speed</p> <p>$n_s = \frac{60 \times f}{P}$</p> <p>$Slip = \frac{n_s - n_r}{n_s}$</p>	
---	--

FORMULA SHEET**RLC CIRCUITS**

$X_L = 2\pi fL$	$X_C = \frac{1}{2\pi fC}$	$F_o = \frac{1}{2\pi\sqrt{LC}}$	$I_L = I_R = I_C = I$	$V_L = \sqrt{3} V_{ph}$	$S = \sqrt{3} V_L I_L$
$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$V_L = I_L Z$	$V_C = I_C X_C$	$V_L = I_L X_L$	$P = \sqrt{3} \times V_L \times I_L \times \cos \theta$	$S = \sqrt{3} V_L I_L \sin \theta$
$\cos \theta = \frac{P}{S}$	$V_T = \sqrt{V_L^2 + (V_L - V_C)^2}$	$\cos \theta = \frac{R}{Z}$	$I_T = \frac{V_L}{Z}$	$V_T = \sqrt{V_L^2 + (V_L - V_C)^2}$	$P = P_1 + P_2$
$\cos \theta = \frac{V_L}{V_T}$	$V_T = \sqrt{V_L^2 + (V_L - V_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$	$I_T = \frac{V_L}{Z}$	$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times n$	Two-wattmeter method
$Q = \sqrt{3} V_L I_L \sin \theta$	$V_L = I_L Z$	$\cos \theta = \frac{V_R}{V_T}$	$I_T = \frac{V_L}{Z}$	$V_L = \sqrt{3} V_{ph}$	Star
$Q = \sqrt{3} V_L I_L \sin \theta$	$V_C = I_C X_C$	$\cos \theta = \frac{R}{Z}$	$I_T = \frac{V_L}{Z}$	$V_L = \sqrt{3} V_{ph}$	Delta
$Q = \sqrt{3} V_L I_L \sin \theta$	$V_L = I_L X_L$	$\cos \theta = \frac{V_L}{V_T}$	$I_T = \frac{V_L}{Z}$	$V_L = I_L \times Z^p$	$I_L = I_{ph}$
$Q = \sqrt{3} V_L I_L \sin \theta$	$V_T = \sqrt{V_L^2 + (V_L - V_C)^2}$	$\cos \theta = \frac{V_L}{V_T}$	$I_T = \frac{V_L}{Z}$	$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times n$	Parallel

THREE-PHASE AC GENERATION

$I_L = I_{ph}$	$V_L = \sqrt{3} V_{ph}$	$S = \sqrt{3} V_L I_L$	$P = P_1 + P_2$	$Q = \sqrt{3} V_L I_L \sin \theta$	THREE-PHASE TRANSFORMERS
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$V_L = \sqrt{3} V_{ph}$	Star
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$V_L = \sqrt{3} V_{ph}$	Delta
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$V_L = \sqrt{3} V_{ph}$	$I_L = I_{ph}$
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$P = \sqrt{3} \times V_L \times I_L \times \cos \theta \times n$	Two-wattmeter method
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$P = P_1 + P_2$	$P = P_1 + P_2$
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$Q = \sqrt{3} V_L I_L \sin \theta$	$Q = \sqrt{3} V_L I_L \sin \theta$
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$Q = \sqrt{3} V_L I_L \sin \theta$	$Q = \sqrt{3} V_L I_L \sin \theta$
$V_L = \sqrt{3} V_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = \sqrt{3} I_{ph}$	$I_L = I_{ph}$	$V_L = \sqrt{3} V_{ph}$	$V_L = \sqrt{3} V_{ph}$

$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_T = V_R = V_C = V_L$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$

PARALLEL

$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$
$V_L = V_R = V_C = V_T$	$I_R = \frac{V_R}{R}$	$I_C = \frac{V_C}{X_C}$	$I_L = \frac{V_L}{X_L}$	$I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$	$\cos \theta = \frac{V_R}{V_T}$

STAR



TOTAL: 200

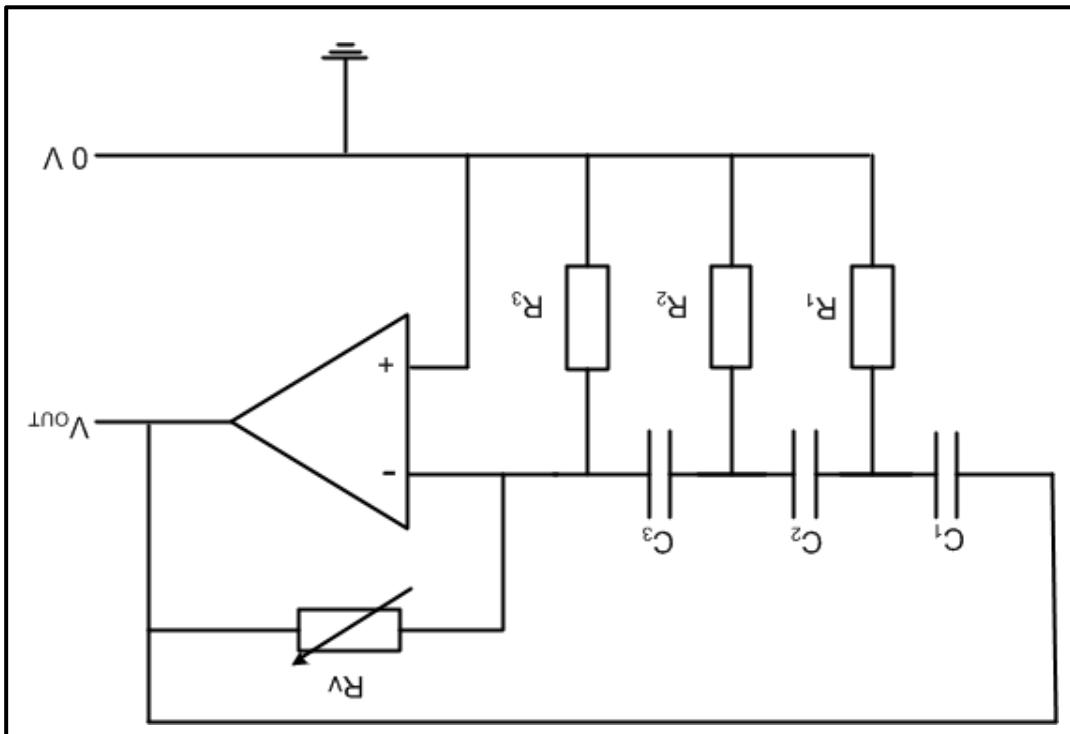
[50]

- 7.12 State ONE application of a differentiator.
(1)
- 7.11 Name the output waveform of a differentiator circuit when a triangular input wave is applied.
(1)
- 7.10 Describe the function of the dual DC supply to an op amp.
(3)
- 7.9.4 State the type of feedback used in this oscillator.
(1)
- 7.9.3 Identify the output waveform of the oscillator.
(1)
- 7.9.2 Calculate the oscillating frequency of the oscillator.
(3)
- 7.9.1 State TWO applications of the oscillator.
(2)

$$R_1 = R_2 = R_3 = 12 \text{ k}\Omega \quad C_1 = C_2 = C_3 = 260 \text{ nF}$$

Given:

FIGURE 7.5: RC PHASE-SHIFT OSCILLATOR CIRCUIT



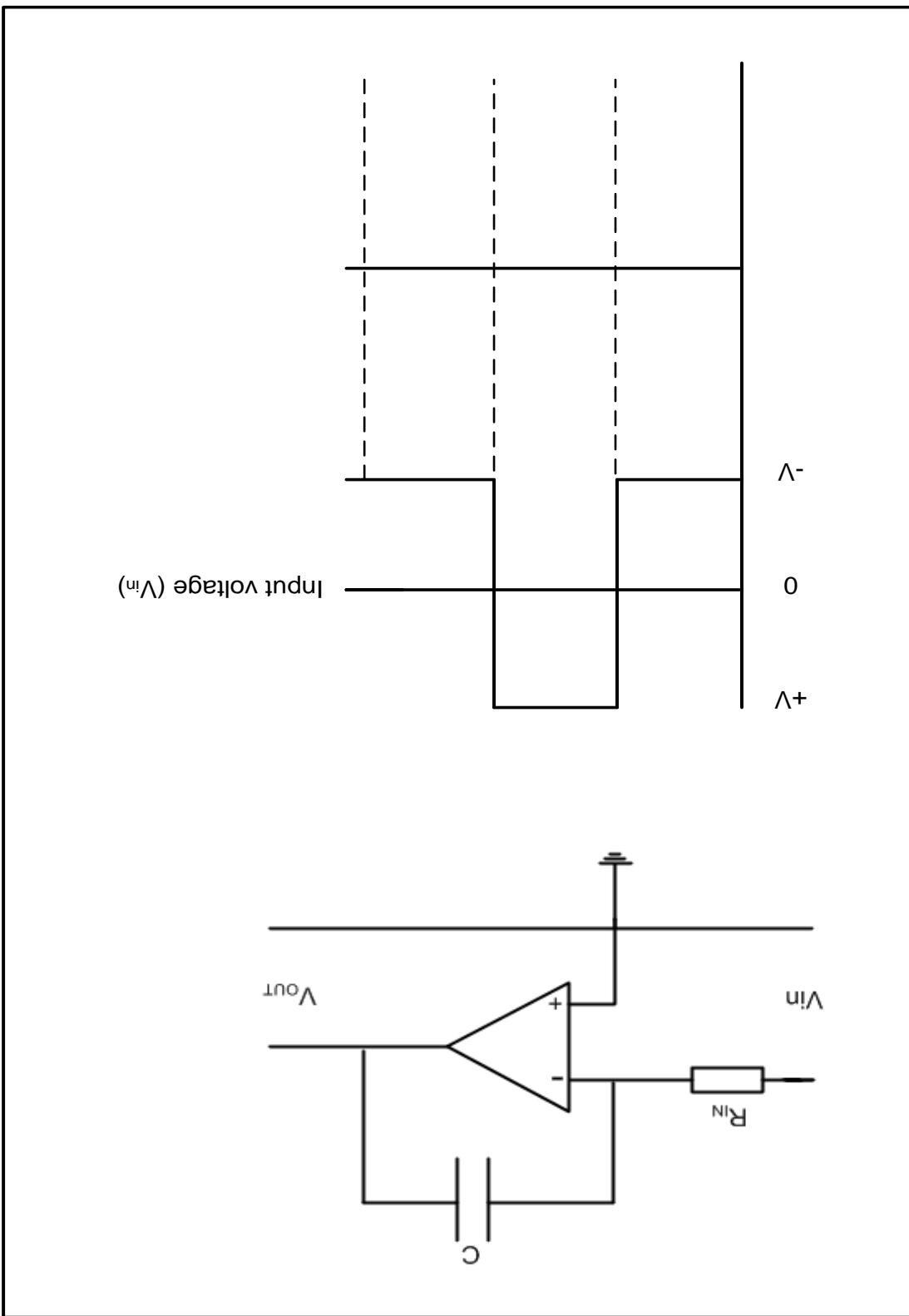
Refer to FIGURE 7.5 below and answer the questions that follow.

7.9



- (3) 7.8.2 Describe the function of the capacitor in this op amp circuit.
- (6) 7.8.1 Draw and label the given input waveform and, in line directly below it, draw the output waveform.

FIGURE 7.4: INTEGRATOR OP AMP CIRCUIT



7.8 Refer to FIGURE 7.4 below and answer the questions that follow.



7.7.4 Calculate the output voltage if an input signal of 6 V is applied to the op amp. (3)

7.7.3 Calculate the output voltage if an input signal of 6 V is applied to the op amp. (2)

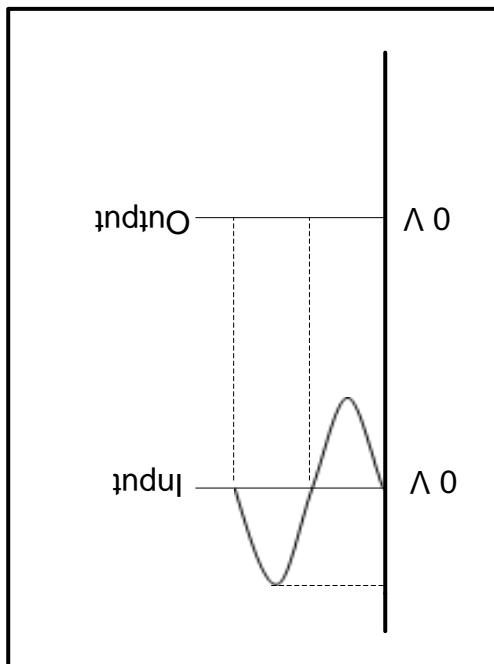
$$\begin{aligned} R_f &= 12 \text{ k}\Omega \\ R_{in} &= 3,3 \text{ k}\Omega \\ V_{in} &= 6 \text{ V} \end{aligned}$$

Given:

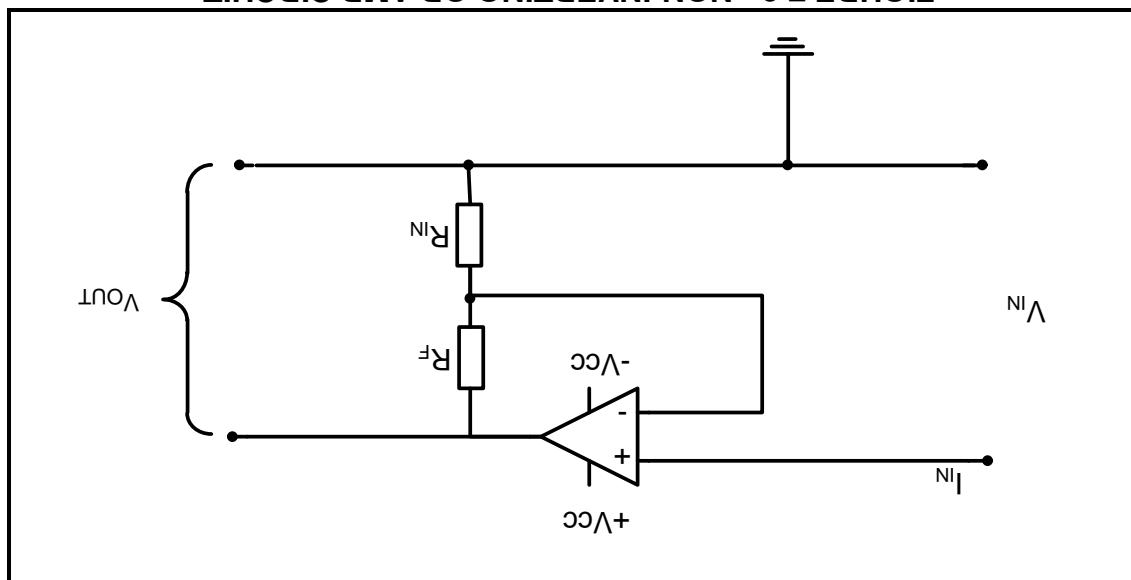
7.7.2 Calculate the voltage gain if the feedback resistor has a value of 3,3 kΩ. (3)



(3)

FIGURE 7.3: OUTPUT WAVEFORM**FIGURE 7.3 below.**

7.7.1 Draw the input and output waveforms on the same Y-axes, as shown in

FIGURE 7.2: NON-INVERTING OP AMP CIRCUIT

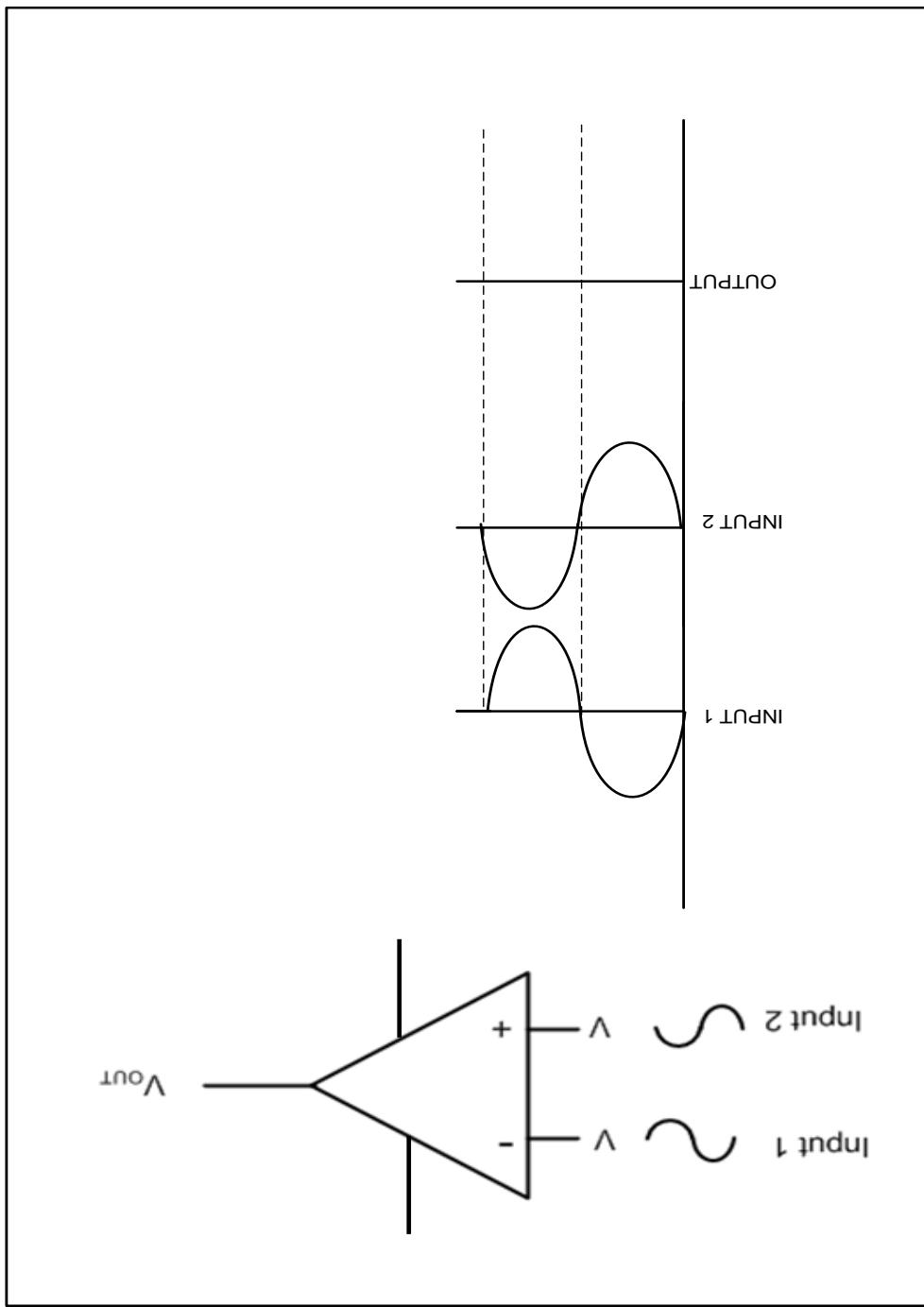
7.7 Refer to FIGURE 7.2 below and answer the questions that follow.

7.7



(3)

FIGURE 7.1: OP AMP

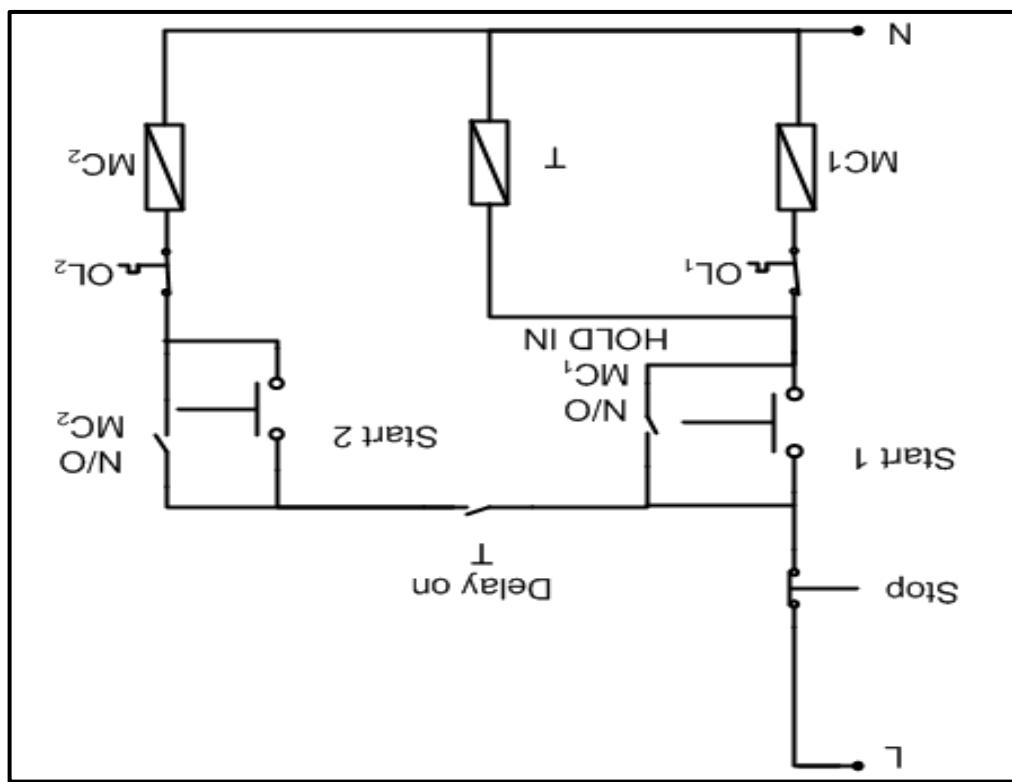


- 7.1 Draw and label the symbol of an operational amplifier (op amp). (5)
- 7.2 State THREE characteristics of an ideal op amp. (3)
- 7.3 Describe why op amp circuits are placed in an integrated circuit (IC) package. (2)
- 7.4 Describe what the term negative feedback means in respect of an op amp. (3)
- 7.5 State TWO advantages of negative feedback. (2)
- 7.6 Refer to FIGURE 7.1 below and draw the output of an ideal op amp in relation to the input waveforms shown. (2)

QUESTIONS 7: AMPLIFIERS



- 6.1 Answer the following questions in respect of PLCs.
- (1) 6.1.1 Write the abbreviation PLC in full.
- (2) 6.1.2 State TWO advantages of a PLC system over relay logic.
- (2) 6.1.3 Name TWO input devices that may be connected to a PLC.
- (1) 6.1.4 Name ONE component that is still used to switch high-current devices on or off.
- (3) 6.1.5 Define the term program in relation to a PLC.
- (1) 6.1.6 Name ONE device used to control a PLC remotely.
- (5) 6.1.7 Draw a block diagram to illustrate the components of a PLC system.
- (6) 6.2 Simplify the following expression with Boolean algebra:
- $$X = \underline{D}E\underline{F} + \underline{D}\underline{E}F + D\underline{E}F + D\underline{E}\underline{F}$$
- (6) 6.3 Draw a three-variable Karnaugh map and simplify the following Boolean expression:
- $$X = \underline{A}B\underline{C} + \underline{A}\underline{B}\underline{C} + A\underline{B}C$$
- (8) 6.4 Refer to the circuit in FIGURE 6.1 below.



QUESTION 6: LOGIC



[20]

(2) more capacitive.

5.5 State, with a reason, whether the circuit in FIGURE 5.1 is more inductive or

(2)

5.4.4 Q-factor of the circuit when the circuit is at resonance (3)

5.4.3 Impedance of the circuit (3)

5.4.2 Capacitive reactance of the capacitor (3)

5.4.1 Inductive reactance of the inductor (3)

Calculate the:

$$f = 50 \text{ Hz}$$

$$V = 240 \text{ V}$$

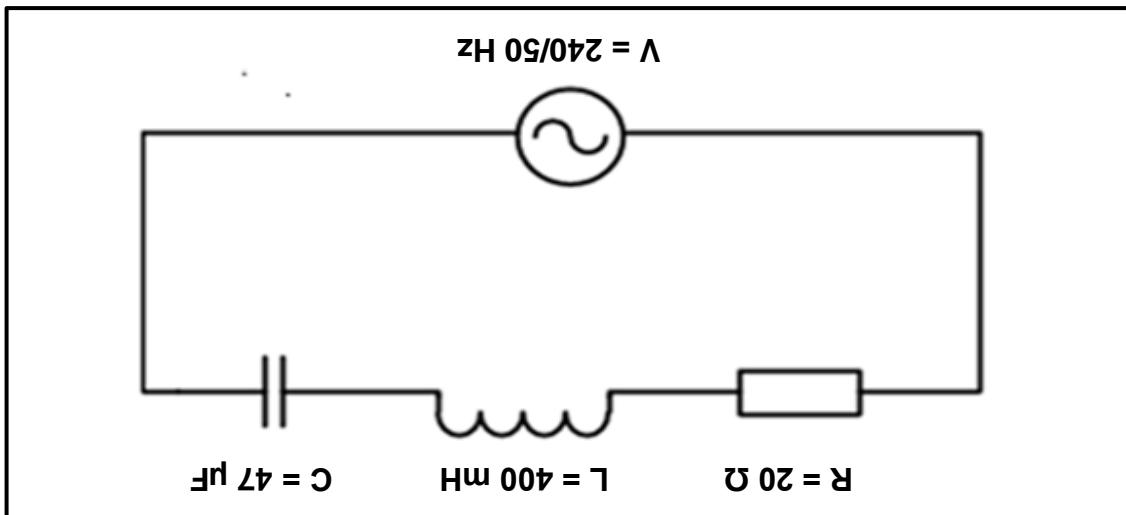
$$C = 47 \mu\text{F}$$

$$L = 400 \text{ mH}$$

$$R = 20 \Omega$$

Given:

FIGURE 5.1: RLC SERIES CIRCUIT



5.4 Refer to the diagram in FIGURE 5.1 below.

5.3 Explain the term resonance with reference to an RLC circuit. (3)

5.2 State how an increase in capacitance will affect the reactance of a capacitor. (1)

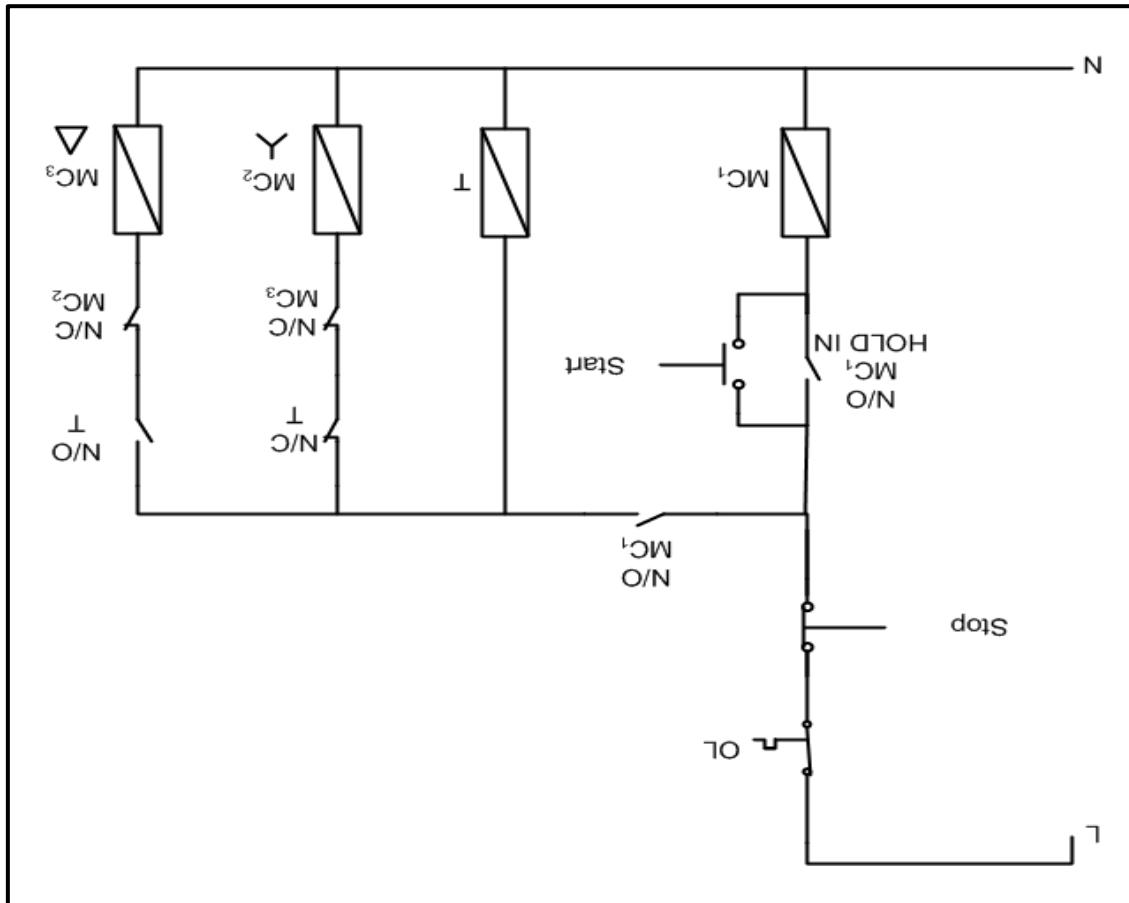
5.1 State TWO factors that influence the value of the reactance of a coil when connected across an AC supply. (2)

QUESTION 5: RLC



- [40]
- (1) State how the number of pole pairs of an induction motor affects the speed of a motor.
- 4.10 (3) Describe why induction motors must be supplied with a constant frequency.
- (5) 4.8.4 Describe the interlocking used in the circuit to prevent the motor from being switched into delta while still connected in star.
- (3) 4.8.3 Describe the function of the overload unit in the starter.
- (3) 4.8.2 State why it is necessary to reduce the starting current of a three-phase induction motor.
- (3) 4.8.1 Describe how a star-delta starter reduces the starting current of the motor.
- 4.9 (3) 4.8.4 Describe why induction motors must be supplied with a constant frequency.
- 4.10 (1) State how the number of pole pairs of an induction motor affects the speed of a motor.

FIGURE 4.1: CONTROL CIRCUIT OF A STAR-DELTA STARTER



4.8 FIGURE 4.1 below represents the control circuit of a star-delta starter.



- 4.1 State ONE advantage of a three-phase induction motor over a single-phase induction motor. (1)
- 4.2 Describe why it is important that the rotor of a motor rotates freely before it is energised. (2)
- 4.3 State TWO electrical tests that must be done on a motor before it is energised. (2)
- 4.4 Describe ONE condition that may exist if there is an electrical connection between the rotor and the stator of a three-phase induction motor. (2)
- 4.5 State TWO losses that occur in a three-phase motor. (2)
- 4.6 A three-phase delta-connected motor, rated at 15 kVA, is connected to a 380 V/50 Hz supply. The motor has a power factor of 0,8 and an efficiency of 95%. Calculate:
- $V_L = 380 \text{ V}$
 $S = 15 \text{ kVA}$
 $f = 50 \text{ Hz}$
 $p.f. = 0,8$
 $\eta = 95\%$
- Given:
- 4.7 Answer the following questions with reference to a three-phase induction motor.
- (1) State what will happen to the output power of the motor if the efficiency of the motor has been improved.
- (2) Describe what will happen to the reactive power of the motor if the power factor of the motor has been improved. Structure your answer with reference to voltage, current and power.
- (3) State what will happen to the output power of the motor if the motor is turned over.

QUESTION 4: THREE-PHASE MOTORS AND STARTERS



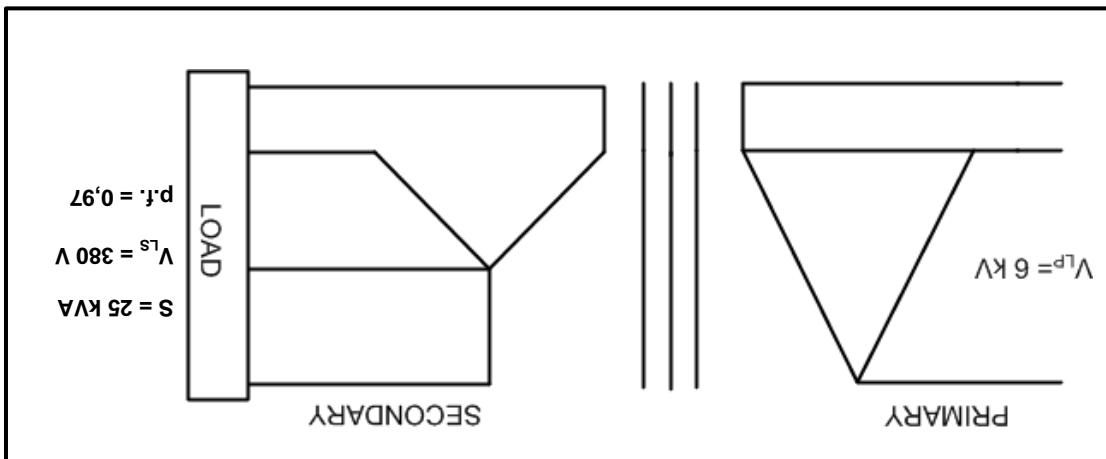
- [20]
- 3.6 State why regular maintenance of transformers is important.
(2)
- 3.5 Explain why the secondary turn of a distribution transformer is connected in star.
(2)
- 3.4.4 Transformation ratio
(3)
- 3.4.3 Primary phase current
(3)
- 3.4.2 Primary line current
(3)
- 3.4.1 Secondary line current
(3)

Calculate the:

$$\begin{aligned} p.f. &= 0,97 \text{ lagging} \\ V_{Ls} &= 380 \text{ V} \\ V_{LP} &= 6 \text{ kV} \\ S &= 25 \text{ kVA} \end{aligned}$$

Given:

FIGURE 3.1: THREE-PHASE TRANSFORMER



- 3.4 FIGURE 3.1 below represents the delta-star connection of a three-phase transformer.
(1)
- 3.3 State where a delta-star transformer connection is used.
(1)
- 3.2 Name TWO cooling methods used in a transformer.
(2)
- 3.1 State the purpose of a transformer.
(1)

QUESTIONS 3: THREE-PHASE TRANSFORMERS



[20]

$$P_1 = 100 \text{ W}$$

$$P_2 = 250 \text{ W}$$

Given:

- 2.4 The two-wattmeter method is used to measure the power drawn by an induction motor. The readings on the wattmeters are 100 W and 250 W respectively. Calculate the total input power.

- 2.3.4 State ONE economic benefit of improving the power factor. (1)

- 2.3.3 State what will happen to the current drawn by the load if the power factor of the load is improved. (1)

- 2.3.2 Impedance of the load (3)

- 2.3.1 Phase current (3)

Calculate the:

$$I_L = 30 \text{ A}$$

$$V_L = 380 \text{ V}$$

$$\text{p.f.} = 0,75 \text{ lagging}$$

Given:

- 2.3 A balanced three-phase inductive load is connected in delta across a three-phase supply. The load draws a current of 30 A from the 380 V/50 Hz supply. It has a power factor of 0,75 lagging.

- 2.2 Draw a neat, labelled diagram that represents the waveforms of a three-phase AC-generated system. (5)

- 2.1.2 Reactive Power (2)

- 2.1.1 Active Power (2)

Define the following terms:

QUESTION 2: THREE-PHASE AC GENERATION

[10]

- 1.4 Explain why a person under the influence of alcohol may not operate machinery in the workplace. (2)

- 1.3 State FOUR points in the procedure that should be followed when a person is experiencing an electric shock. (4)

- 1.2 Distinguish between an unsafe act and an unsafe condition. (2)

- 1.1 State TWO unsafe acts that may lead to an accident. (2)

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY



1. This question paper consists of SEVEN questions.
2. Answer ALL the questions.
3. Sketches and diagrams must be large, neat and fully labelled.
4. Show ALL calculations and round off answers correctly to TWO decimal places.
5. Number the answers correctly according to the numbering system used in this question paper.
6. You may use a non-programmable calculator.
7. Show the units for all answers of calculations.
8. A formula sheet is provided at the end of this question paper.
9. Write neatly and legibly.

INSTRUCTIONS AND INFORMATION



AFTERNOON SESSION

This question paper consists of 13 pages and a 2-page formula sheet.

TIME: 3 hours

MARKS: 200

FEBRUARY/MARCH 2017

ELECTRICAL TECHNOLOGY

ELTT.1

GRADE 12

SENIOR CERTIFICATE
NATIONAL

REPUBLIC OF SOUTH AFRICA
Basic Education
Department:

basic education

