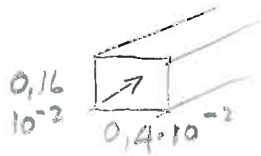
EXAM 1 2014 55214

VRAAG 1

a)



charge in 1m of bar

(X) area = $0,4 \cdot 10^{-2} \times 0,16 \cdot 10^{-2} = 6,4 \cdot 10^{-4}\ m^2$ -6 X

$C/m^3 = \frac{1,6 \cdot 10^{-19}}{1e^-} \cdot \frac{10^{29}}{1\ m^3} = 1,6022 \cdot 10^{10}\ C/m^3$ (2)

$C/m = 1,6022 \cdot 10^{10} \times 6,4 \cdot 10^{-4} = 10,254 \cdot 10^{6}\ C/m$ (2) x 10^6

current $\left(\frac{C}{s}\right) = 10,254 \cdot 10^{6} \left(\frac{C}{m}\right) \times 156,04 \cdot 10^{-6} \left(\frac{m}{s}\right) = \underline{1600\ A}$ (2) 15,98

(av. vel)

[6]

b)

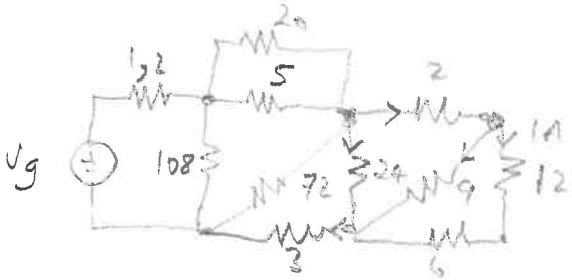
$i = \frac{380}{100k} = 3,8\ mA$

$25000i = 3,8 \cdot 10^{-3} \cdot 25000 = 95\ V$ (2)

$V_0 = \frac{60k \cdot 95}{(40+60)k} = \underline{57\ V}$ (2)

[4]

c)



Voltage across 9Ω resistor

$V_9 = 1(12+6) = 18\ V$ (2)

Current in 9Ω resistor = $\frac{18}{9} = 2A$

Current in 2Ω resistor = $1 + 2 = 3A$

Voltage across 24Ω resistor = $(2 \times 3) + 18V = 24\ V$

Current in 24Ω resistor is $\frac{24}{24} = 1A$

Current in 3Ω resistor is $i_{24} + i_9 + i_6 = 1 + 2 + 1 = 4A$ (2)

voltage across $72\Omega = 24 + (3 \times 4) = 36\ V$

$\therefore$ current in 72Ω resistor = $\frac{36}{72} = \underline{0,5\ A}$ (2) [6]

d) To work out power delivered, work out total circuit resistance:

$(12+6) \| 9 = 6$; $(2+6) \| 24 = 6$; $(6+3) \| 72 = 8$

$8 + (20 \| 5) = 12$; $12 \| 108 = 10,8$; $1,2 + 10,8 = 12\ \Omega$ (2)

Power $V_g = \frac{6^2}{12} = \underline{3\ W}$ (2) [4]

VRAAG 2

a) At middle node

$$\frac{V_x - 150}{25} + \frac{V_x}{80} + \frac{V_x - (150 - 15 I_{sc})}{40} = 0 \qquad (i)$$

$$i_x = \frac{150 - V_x}{25} \qquad (ii) \qquad (4)$$

(ii) → (i) × 80 $\quad 3{,}2\,V_x - 480 + V_x + 2V_x - 300 + \frac{30}{25}(150 - V_{sc}) = 0$

$$5V_{sc} - 600 = 0$$

$$V_{sc} = 120 \qquad (3) \qquad [7]$$

b) Three mesh equations:

$$50 = 5(I_1 - I_2) + 20(I_1 - I_3) \qquad (i)$$

$$0 = 5(I_2 - I_1) + 1I_2 + 4(I_2 - I_3) \qquad (ii)$$

$$0 = 20(I_3 - I_1) + 4(I_3 - I_2) + 15 I_x \qquad (iii)$$

constraint $\quad I_x = I_1 - I_3 \qquad (iv) \qquad (4)$

(iv) → (iii) $\quad 0 = 20I_3 - 20I_1 + 4I_3 - 4I_2 + 15I_1 - 15I_3$

$$0 = -5I_1 - 4I_2 + 9I_3 \qquad (v)$$

so

$$50 = 25I_1 - 5I_2 - 20I_3$$

$$0 = -5I_1 + 10I_2 - 4I_3$$

$$0 = -5I_1 - 4I_2 + 9I_3 \qquad (4) \qquad [8]$$

c) Thevenin voltage between a and b? Just sc voltage across 33 Ω

$$V_{ab} = 150 - 15 I_x = 150 - \frac{15(150 - 120)}{25} = 132\ V \qquad (2)$$

Measure with meter or oscilloscope

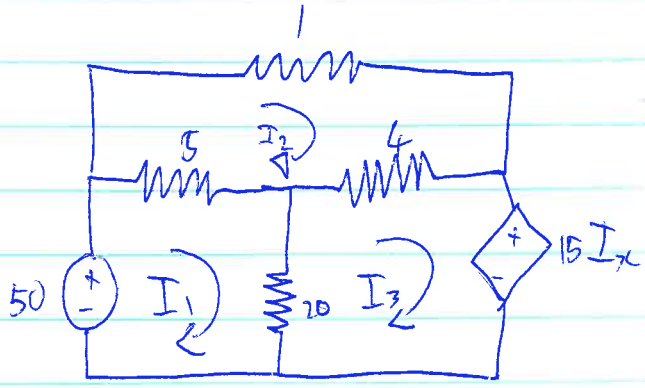
Put sc between a and b and measure

current I_{sc}.

Then $R_{th} = \frac{V_{ab}}{I_{sc}} \qquad (3) \qquad [5]$

Vraag 2

b) $I_2 = I_x$



$$50 = 5(I_1 - I_2) + 20(I_1 - I_3)$$

$$I_2 + 4(I_2 - I_3) + 6(I_2 - I_1) = 0$$

$$20(I_3 - I_1) + 4(I_3 - I_2) + 15 I_2 = 0$$

$$\begin{aligned} 50 &= 25 I_1 - 5 I_2 - 20 I_3 \\ 0 &= -5 I_1 + 10 I_2 - 4 I_3 \\ 0 &= -20 I_1 + 11 I_2 + 24 I_3 \end{aligned}$$

2nd sol.:

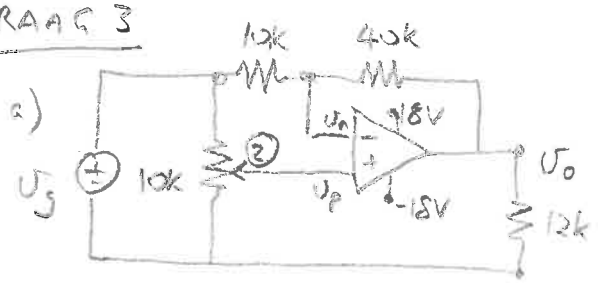
$$20(I_3 - I_1) + 4(I_3 - I_2) + 15 I_x = 0$$

~~$-20 I_1 + 24 I_3$~~

$$-20 I_1 - 4 I_2 + 24 I_3 = -15 I_x$$

VRAAG 3

a)



pt ② in middle

$U_n = U_p = U_g/2$ (2)

$\times 1000 \rightarrow mV$ (at – node)

$\frac{U_n - U_g}{10} + \frac{U_n - U_o}{40} = 0$ (2)

$4(U_n - U_g) + U_n - U_o = 0$

$4\left(\frac{U_g}{2} - U_g\right) + \frac{U_g}{2} = U_o$

$U_o = -\frac{3}{2} U_g$ (2)

$U_g = 10V : U_o = -15V$ (i) (2)

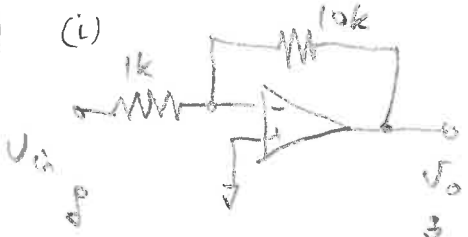
$U_g = 2V : U_o = -3V$ (ii) [8]

(i) $P_{12k} = \frac{-15^2}{12k} = 18,75\ mW$

(ii) $P_{12k} = \frac{-3^2}{12k} = 0,75\ mW$

must get right values & gain units [4]

b) (i)

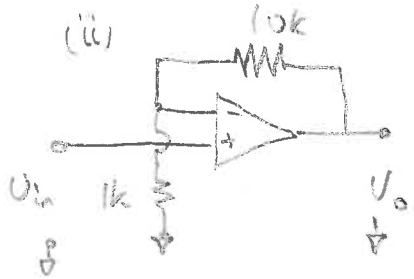


inverting

gain $= -10^3 = \frac{R_f}{R_s}$

(3)

(ii)



non-inverting

gain $= 11 = \frac{R_s + R_f}{R_s}$

(3)

[6]

c) Input resistance of :

(i) as $U_n = 0$

$R_{in} = 1k\Omega$

(1)

(ii) as $U_p \rightarrow U_n$ resistance $= \infty \Omega$ for ideal op amp

$R_{in} = \infty\ \Omega$

(1)

[2]

VRAAG 4

a) $i = \frac{400.10^{-3}}{5.10^{-6}} t = 80.10^3 t \qquad 0 \le t \le 5\mu s$

$i = 400.10^{-3} \qquad 5 \le t \le 20\mu s$

$i = \frac{300.10^{-3}}{30.10^{-6}} t - 0,5 = 10^4 t - 0,5 \qquad 20 \le t \le 50\mu s.$ (3)

$$q = \int_0^{5.10^{-6}} 8.10^4 t\, dt + \int_{5.10^{-6}}^{20.10^{-6}} 0,4\, dt$$

$$= 8.10^4 \frac{t^2}{2}\Big|_0^{5.10^{-6}} + 0,4\left(15.10^{-6}\right) \qquad (2)$$

$$= 4.10^4\left(25.10^{-12}\right) + 6.10^{-6}$$

$q = 7\mu C.$ (1) [6]

b) $v = \frac{1}{c}\int_0^{t_1} i\, dt + \frac{1}{c}\int_{t_1}^{t_2} i\, dt + 0 \qquad i = C\frac{dv}{dt}$ ✓

$C = 0,47\mu F$

$$= 2,128.10^6 \int_0^{5.10^{-6}} 8.10^4 x\, dx + 2,128.10^6 \int_{5.10^{-6}}^{20.10^{-6}} 0,4\, dx$$ ✓

$$= 2,128.10^6 \left[8.10^4 \frac{x^2}{2}\Big|_0^{5.10^{-6}} + 0,4x\Big|_{5.10^{-6}}^{20.10^{-6}} \right]$$

$$= 2,128.10^6 \left[4.10^4\left(25.10^{-12}\right) + 0,4\left(15.10^{-6}\right) \right]$$

$$\left(10^{-6}\right) \qquad + \left(6.10^{-6}\right)$$

$v = 14,9\ V$

[4]