Fall 2013 HW#1 Solution

1.10

- use equation 1.2 to find V_o for LSB

$$V_{LSB} = 2^{-n} V_{FS} = 2^{-12}(10\,V) = \boxed{2.44\,mV}$$

- use eq. 1.1 to find V_o for MSB

$$V_o = \left[\frac{1}{2}(1) + \left(\frac{1}{2}\right)^2(0) + \left(\frac{1}{2}\right)^3(0) + \ldots \left(\frac{1}{2}\right)^{12}(0)\right] V_{FS}$$

$$V_o = \frac{1}{2}(10V) = \boxed{5\,V}$$

- 1 0 0 1 0 0 1 0 0 1 0 1

$$V_o = \left(\frac{1}{2}(1) + \left(\frac{1}{2}\right)^4 + \left(\frac{1}{2}\right)^7 + \left(\frac{1}{2}\right)^{10} + \left(\frac{1}{2}\right)^{12}\right) V_{FS} \quad \text{eq. 1.1}$$

$$V_o = \boxed{5.72\,mV}$$

1.12

- eq. 1.2

$$V_{LSB} = \left(\frac{1}{2}\right)^8 \cdot V_{FS} = \left(\frac{1}{2}\right)^8 \cdot (5V) = \boxed{19.5\ mV}$$

- Divide the input voltage by V_{LSB}

$$\frac{2.97V}{19.5mV} = 152.06$$

- Round to integer,

$$152.06 \approx 152$$

- Convert to binary

Bit #		decimal value
1	LSB	1
2		2
3		4
4		8
5		16
6		32
7		64
8	MSB	128

Bit#8 Bit#5 Bit#4

$128 + 16 + 8 = 152$

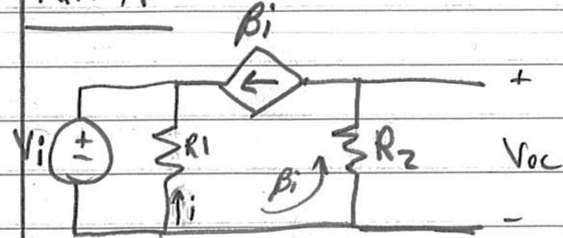
$\boxed{10011000}$ binary = 152 decimal

This is the digital output of the A → D converter.

ECE 255 Fall 2013 HW#1
Prof. Ziaie section Solution

1.26

Part A



Find V_{oc}

- $V_{oc} = \beta i R_2$
- $i = \frac{-V_i}{R1}$

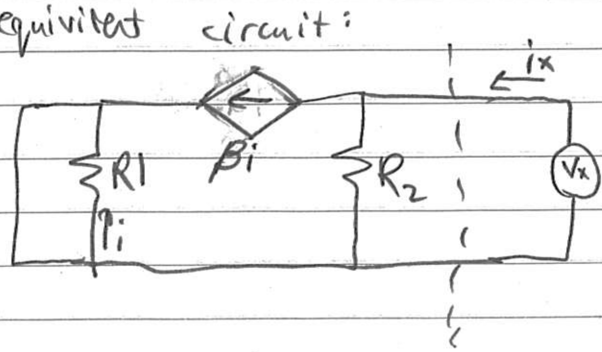
$$V_{oc} = -\beta V_i \frac{R_2}{R_1}$$

$$= -(150)(V_i)\frac{(39k\Omega)}{(100k\Omega)}$$

$$\boxed{V_{oc} = 58.5\, V_i}$$

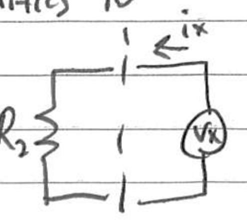
Set source to zero, find R_{th}

equivilent circuit:



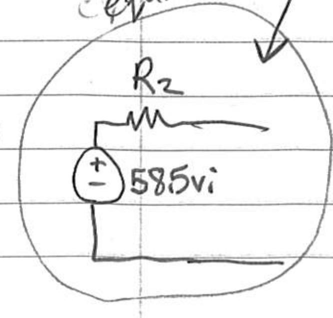
- Because R1 is shorted out, $i = 0$ A.

circuit simplifies to



$$\boxed{R_{th} = \frac{V_x}{i_x} = R_2}$$

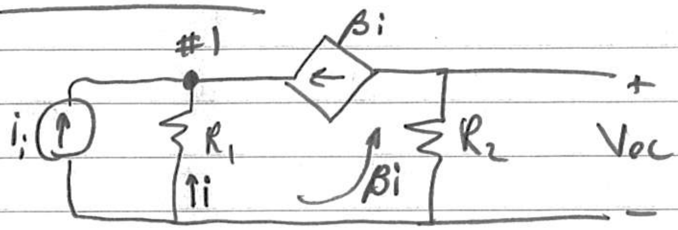
Thevenin equivilent



1.26

Part B

Find V_{oc}



• $V_{oc} = \beta i R_2$

• At Node #1: $i_i + i + \beta i = 0$

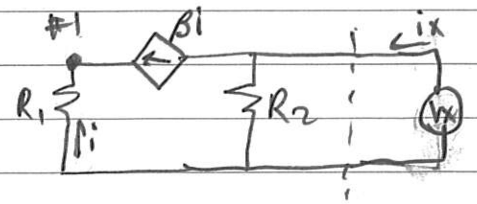
$$i_i + i(1+\beta) = 0$$

– solve for i $\quad i = \frac{-1}{1+\beta} i_i$

• Substitute for i

$$V_{oc} = \beta\left(\frac{-1}{1+\beta}\right) i_i R_2 = \boxed{\left(38.700 \tfrac{V}{A}\right) i_i}$$

Find R_{th}, set $i_i = 0A$

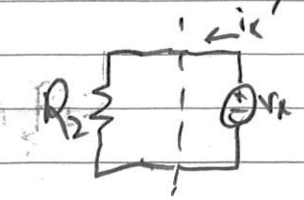


At Node #1: $i + \beta i = 0$

$$i(1+\beta) = 0$$

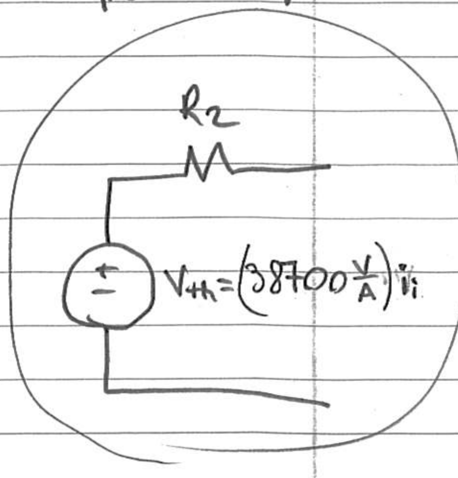
$$i = 0$$

Because $i=0$, circuit simplifies to



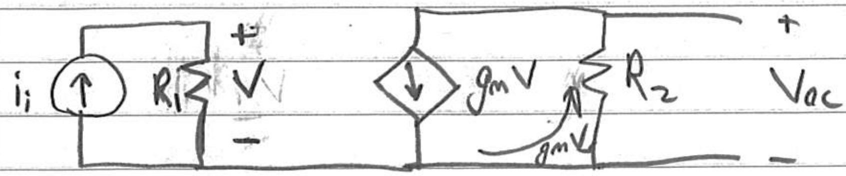
$R_{th} = \frac{V_x}{i_x} = R_2$

Thevenin equivilent



1.29

Find $V_{TH} = V_{OC}$



$V_{OC} = -g_m V R_2$

$V = i_i R_1$

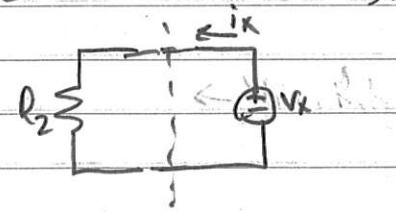
$V_{OC} = -g_m R_1 R_2 i_i$

$= -(0.0025S)(200k\Omega)(1.5M\Omega)$

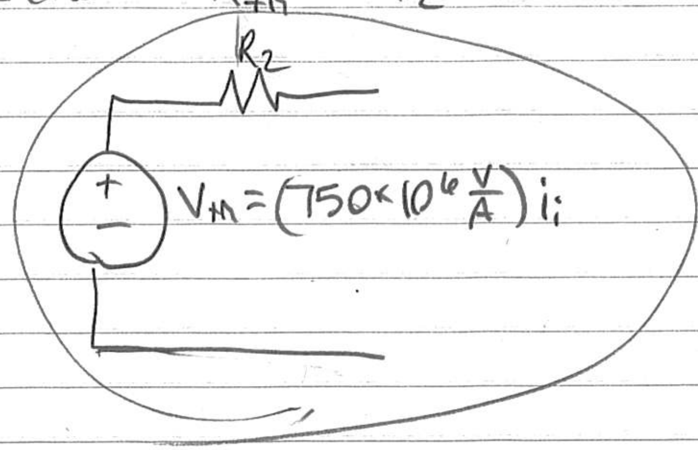
$$\boxed{V_{OC} = (750 \times 10^6 \tfrac{V}{A}) i_i}$$

Find R_{TH} with $i_i = 0A$

w/ $i_i = 0A$, $R_1 V = 0V$, $g_m V = 0A$.
therefore circuit simplifies to



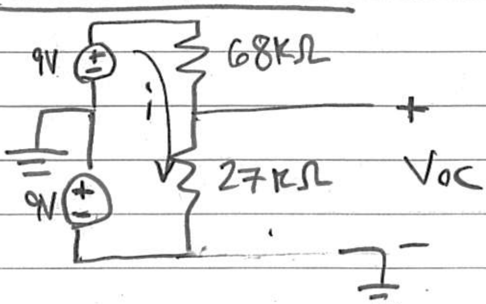
Therefore $R_{TH} = R_2$



1.32

Part A

Find $V_{th} = V_{oc}$



- $V_{oc} = i(27k\Omega) - 9V$
- $-9V + i(68k\Omega) + i(27k\Omega) + -9V = 0$ By KVL

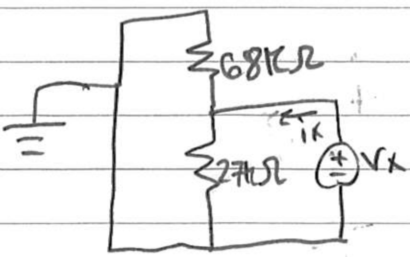
$$i = \frac{18V}{68k\Omega + 27k\Omega}$$

- substitute for i,

$$V_{oc} = \left(\frac{18V}{68k\Omega + 27k\Omega}\right)(27k\Omega) - 9V = \boxed{-3.88V = V_{oc} = V_{th}}$$

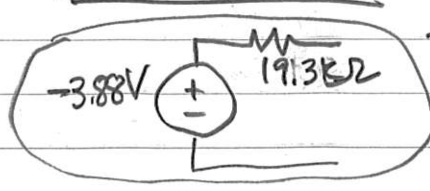
Find R_{th}, set both voltage source to zero

equivalent circuit:



$$R_{th} = \frac{v_x}{i_x} = 68k\Omega \,//\, 27k\Omega$$

$$\boxed{R_{th} = 19.\,k\Omega}$$



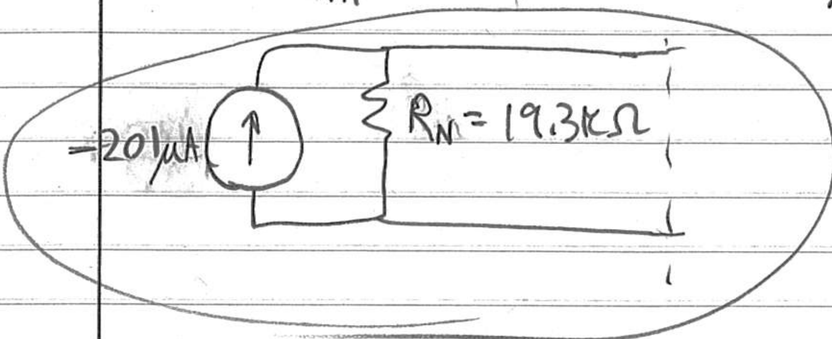
Thevenin equivalent circuit

1.32

Part B

Norton equivilent, use result from part A

$$I_{sc} = \frac{V_{oc}}{R_{th}} = \frac{-3.88\,V}{19.3\,k\Omega} = -201\,\mu A \ , \ R_N = R_{th}$$



Norton equivilent.