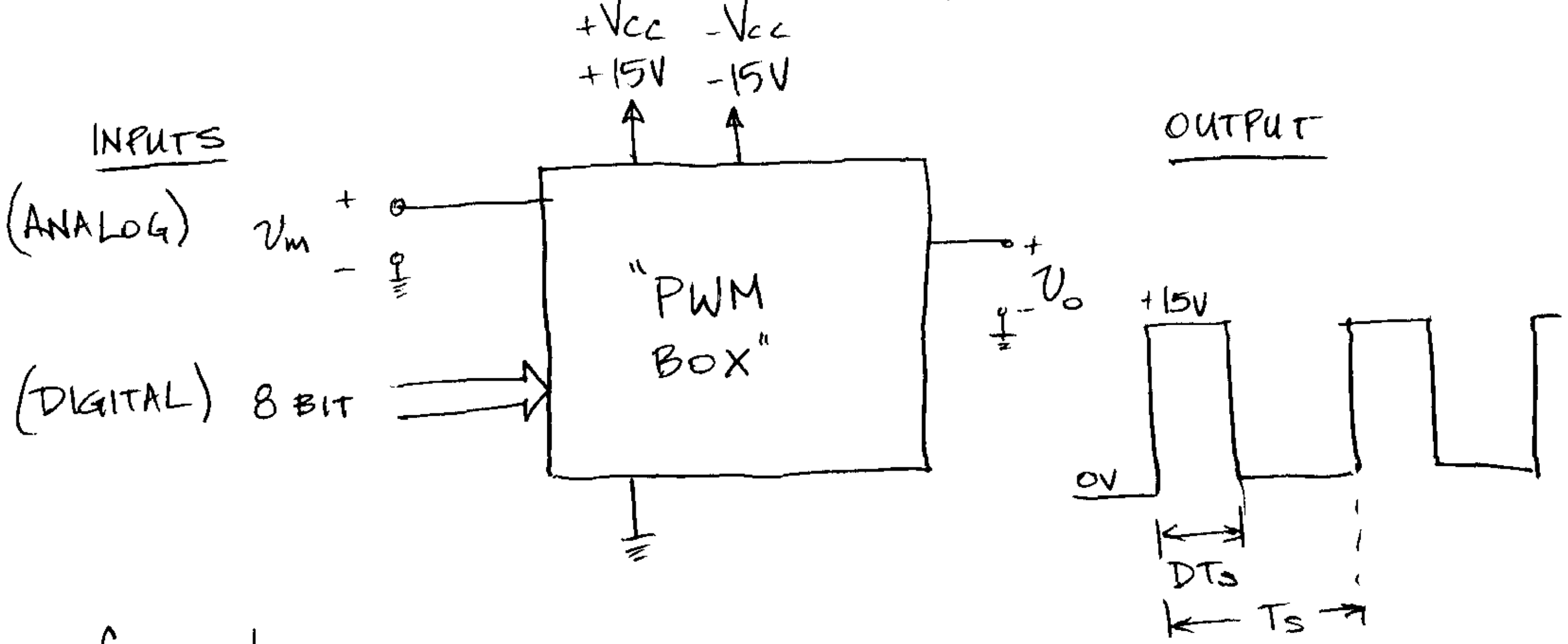
(LECTURE NOTES FOR) LAB #2 9/4/98

PULSE WIDTH MODULATOR: USING A VOLTAGE INPUT TO CONTROL THE DUTY CYCLE OF THE OUTPUT WAVEFORM.

SPECS:



$$f_s = \frac{1}{T_s} = 50\,\text{KHz} \pm 2\%$$

$D \triangleq$ DUTY CYCLE $\quad 0 \le D \le 1$

WITH ANALOG INPUT v_m: $\quad D = \dfrac{v_m}{4V}\,; \quad 0 \le v_m \le 4V$

WITH DIGITAL INPUT:

$$D = \frac{1}{256} \sum_{K=1}^{8} A_K \, 2^{8-K}$$

8-BIT RESOLUTION

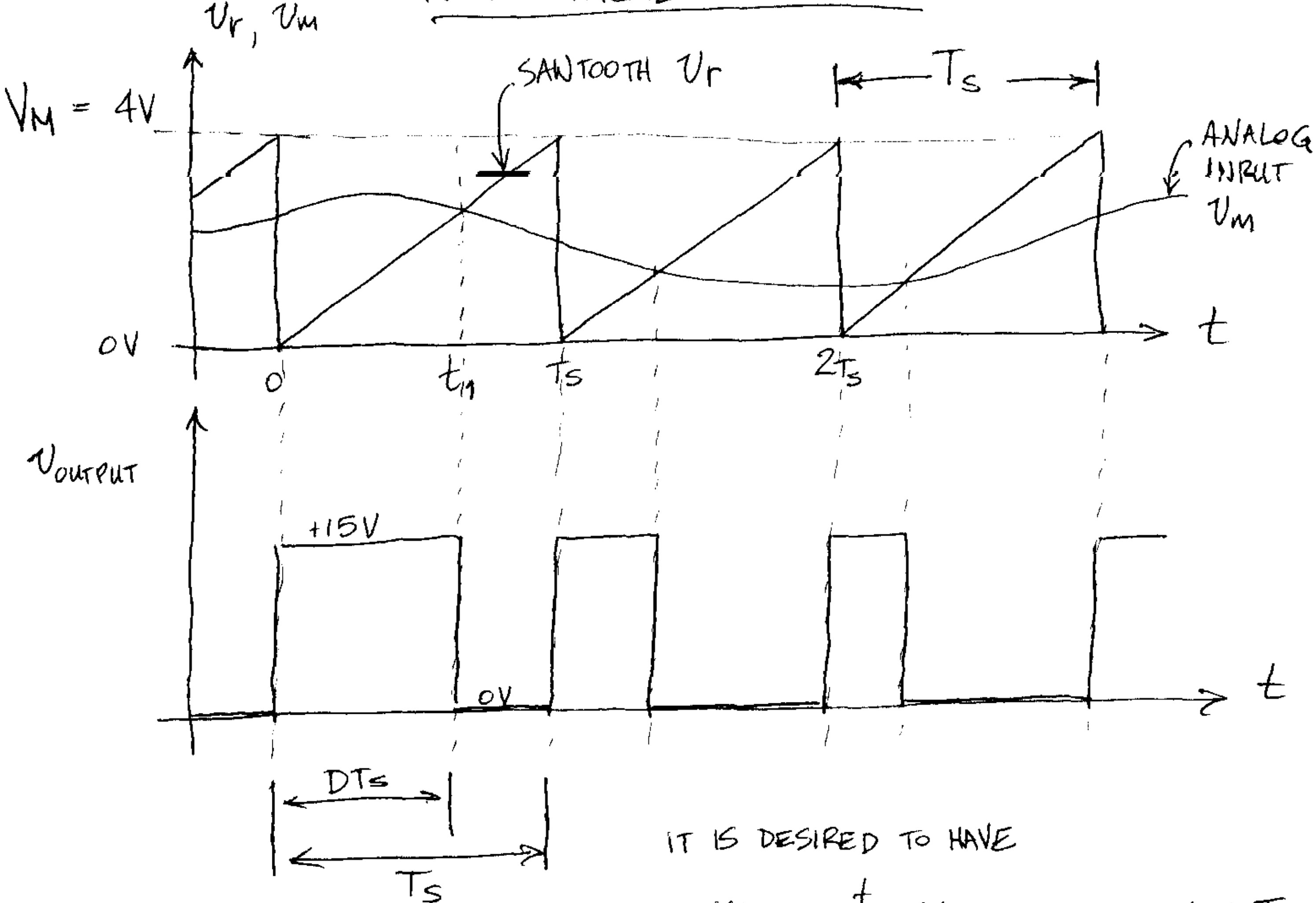
$$\{A_1, A_2, \ldots \; A_8\}$$

MSB .. LSB

EXAMPLE: IF $A_1 = 1$, $A_{i \neq 1} = 0$, THEN

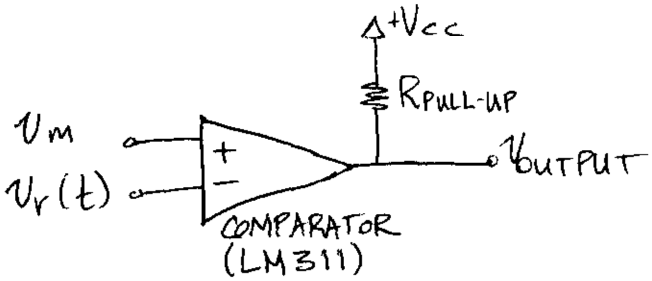
$$D = \frac{1}{256}\left(2^7\right) = \frac{128}{256} = 0.5$$

PWM TYPICAL WAVEFORMS



IT IS DESIRED TO HAVE

$$v_r(t) = \frac{t}{T_S} \cdot V_M \quad ; \quad 0 \le t \le T_S$$



AT TIME t_1: $v_r(t_1) = v_m$

$$\frac{t_1}{T_S} \cdot V_M = v_m$$

$$\frac{t_1}{T_S} = \boxed{\frac{v_m}{V_M} = D}$$

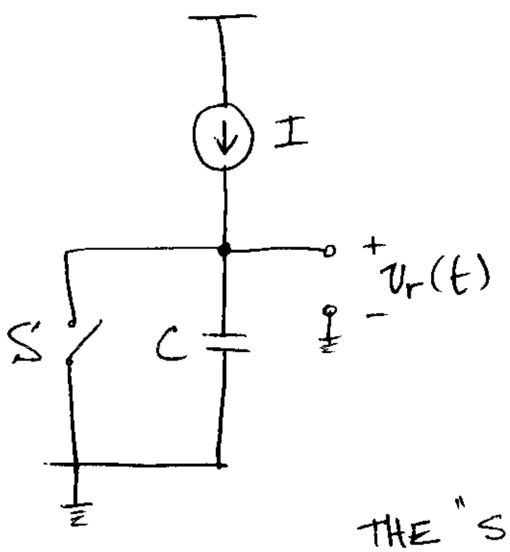
THIS IS A SPEC.

2 PRACTICAL LIMITS OF $v_r(t)$:

- A PERFECTLY LINEAR "RAMP" RISE UP TO V_M
- & AN INSTANTANEOUS FALL BACK TO ZERO.

(THESE ARE NOT ACHIEVABLE IN REAL LIFE, SO MAKE THEM AS CLOSE TO IDEAL AS YOU CAN)

A BASIC IDEA FOR THE SAWTOOTH GENERATOR $v_r(t)$



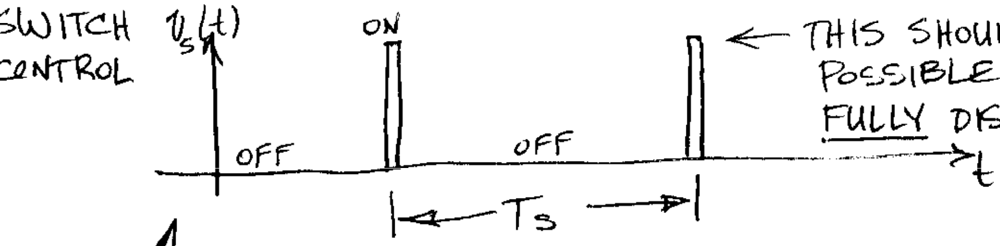
$$i_c(t) = C\frac{dv_c(t)}{dt}$$

$$v_c(t) = \frac{1}{C}\int i_c(t)\,dt$$

IF $i_c(t)$ IS A CONSTANT, $v_c(t)$ BECOMES A RAMP.

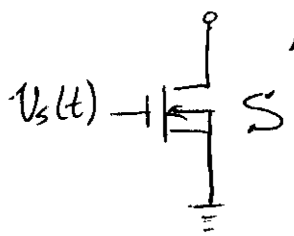
THE "SWITCH" S SHOULD CLOSE ONCE $v_c(t) = V_M$ TO RETURN $v_r(t)$ BACK TO ZERO.

HOW DO WE CONTROL THE SWITCH?



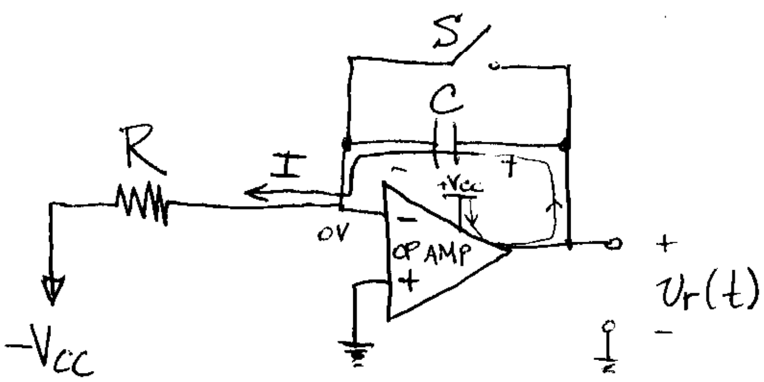
← THIS SHOULD BE AS SHORT AS POSSIBLE, BUT LONG ENOUGH TO <u>FULLY</u> DISCHARGE THE CAPACITOR C.

** THIS WAVEFORM CAN BE PRODUCED USING KNOWLEDGE FROM LAB #1.



← HERE'S ONE IMPLEMENTATION FOR THE SWITCH

TO PRODUCE I,



$$I \cong \frac{0V - (-V_{cc})}{R}$$