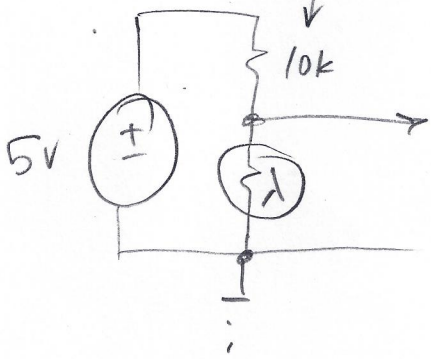
BME-ISE 3511 • Exam VI • 4 December 2020 (15 pts) NAME SOLUTION

1) A light source and CdS photoresistor are used as a motion detector in conjunction with an Arduino Uno microcontroller; whenever a moving object interrupts the light path, its resistance goes up and triggers a state change that eventually turns on a flood light. If the desired state change is from LOW to HIGH whenever motion is detected, draw the circuit that will accomplish this.



∴ low "light" resistance ⇒ lots of voltage division → output LOW

∴ high "dark" resistance → very little voltage division → output HIGH

+3

2) The Arduino Uno has a 10-bit quantization depth when used with an analog source, with an input range of 0 to 5V. What digital value would correspond to an input voltage of 0.114 V from some sensor? What is this digital value in binary?

$2^{10} = 1024$ (+1)

$\frac{0.114}{5} \cdot 1024 = 23.35$ (+1)

→ 23 (+1)

= 0000010111 (+1)

check: $2^0 + 2^1 + 2^2 + 2^4 = 23$ ✓

3) EEG (i.e., electroencephalogram/brainwave) signals have a bandwidth of 150 Hz. What is the absolute minimum sampling frequency that should be used to preserve all the original signal content? What is the sampling period?

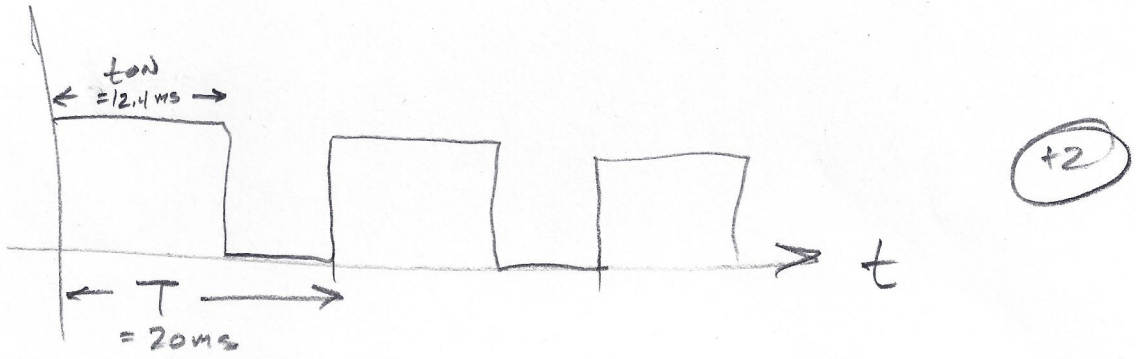
$f_s > 2B$ (+1) (Nyquist - Shannon)

$\therefore$ $f_s \geq 300$ Hz (+1)

$T = \frac{1}{300} \Rightarrow 3.3$ ms (+1)

4) Draw a pulse-width-modulated signal with a period of 20 ms and duty cycle of 62%.

$t_{ON} = 20 \cdot .62 = 12.4$ ms (+1)



(+2)

5) What did you like best about this course?

(+2)

Have an excellent break!