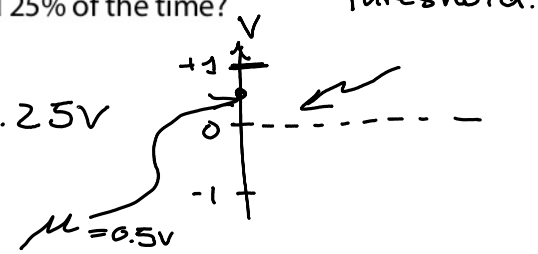
Baseband Transmitters and Receivers

Exercise 1: Gaussian noise with a mean of 0.5 V and a variance of 0.25 V^2 is added to a bipolar signal with levels of ± 1 V. Assuming a decision threshold equally spaced between the two levels, what is the likelihoood of error if $+1$ is transmitted? If -1 is transmitted? What is the average error rate if $+1$ is transmitted 25% of the time?

$\mu = 0.5V \quad \sigma^2 = 0.25V$



receiver sees signal + noise.

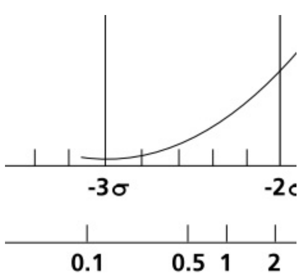
the new mean is $\mu + 1\,V = 0.5 + 1 = 1.5V$

the new variance is unchanged $= \sigma^2 = 0.25 \rightarrow \sigma = \sqrt{0.25} = 0.5$

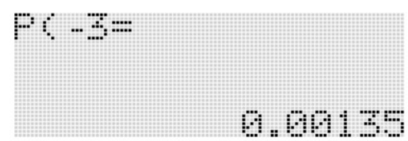
probability of error is probability that signal + noise have value less than threshold = 0V.

normalized threshold = $t = \frac{v - \mu}{\sigma} = \frac{0 - 1.5}{0.5} = -3$

from the graph $P(x < -3) \simeq 0.1\% \approx \underline{1 \times 10^{-3}}$



or from calculator:

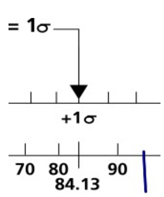


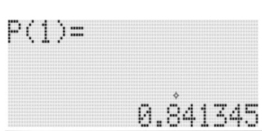
If signal is -1, new $\mu = -1 + 0.5 = -0.5$

prob. of error is prob that signal + noise > 0V

normalized threshold now is $t = \frac{0 - (-0.5)}{0.5} = 1$

$P(x > 1) \simeq \underline{0.84}$

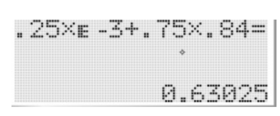




average error rate =

$0.25 \cdot 1 \times 10^{-3} + 0.75 \times 0.84$

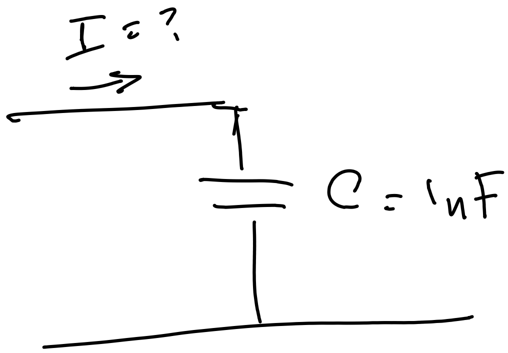
$\simeq 0.63$



Exercise 2: What is the current flowing into a 1nF capacitor if it is being charged at a rate of 10V/μs?

$$V = L\frac{di}{dt}$$

$$I = C\frac{dv}{dt}$$



$$\frac{dV}{dt} = \frac{10V}{1\mu s}$$

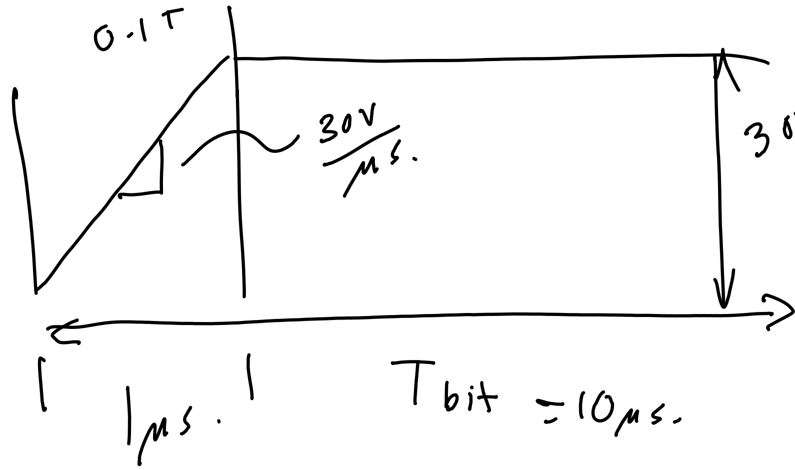
$$I = C\frac{dv}{dt} = 10^{-9}\,\frac{10\times10^{0}}{1\times10^{-6}}$$

$$= 10\times10^{-9+0+6}$$

$$= 10\times10^{-3}$$

10 mA

Exercise 3: The RS-232 standard specifies a maximum slew rate of 30V/”. Assuming a voltage swing of 30 volts, what is the maximum data rate for which two signal level transitions occupy 10 % of the bit period?



MIDTERM EXAM

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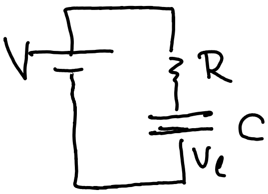
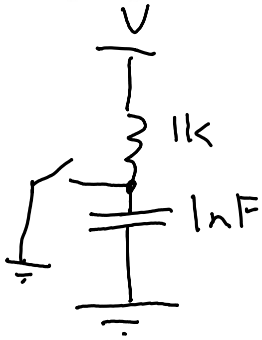
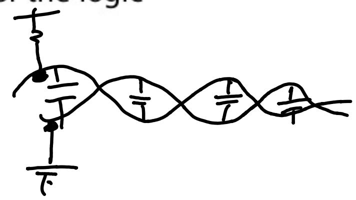
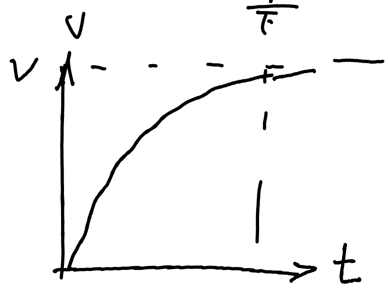
Exercise 4: If the capacitance of the transmission line joining several OC drivers is 1 nF and the pull-up resistor is 1 k", how long will it take for the pull-up to pull the line from 0V to 63% of the logic high voltage?









$$V(t) = V\left(1 - e^{-\frac{t}{RC}}\right)$$

$$= 0.63V$$

$$e^{-\frac{t}{10^3 \cdot 10^{-9}}} = 0.37$$

$$t = -10^{-6} \ln 0.37$$

$$= 10^{-6}$$

Exercise 5: What are the consequences of increasing the delay between polls? What other factor might determine the maximum delay before slave gets access to the bus in a system using polling?

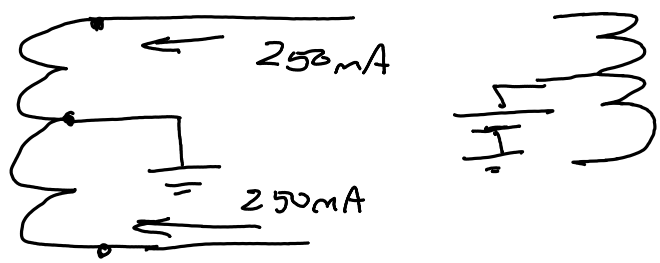
- more time between polls increases maximum & average delay (latency)
- amount of bus time used by other devices increases time between polls.

Exercise 6: Consider a communication bus in a car that connects an airbag activation controller with a collision detector, a passenger-seat occupancy sensor and an airbag-disabling switch. Would it be more appropriate to use a polling- or contention-based bus arbitration protocol? Would it be appropriate for the arbitration protocol to allow different priorities for bus access? If so, what priorities might be assigned the different sensors?

Contention - based is better due to need for low maximum delay.

yes priorities would be appropriate with highest to crash sensor.

Exercise 7: If the common-mode circuit is used to carry 500mA, how much current flows through each half of the transformer secondary? What is the net effect on the flux in the transformer core?



- magnetic fields oppose → net flux due to DC current is zero (no saturation due to DC power supply current).

Exercise 8: When the input to the optocoupler is high, will the output be high or low? Assume a pull-up is connected to the output.

low → output transistor is on & pulls output low.