Chem 988
Winter, 09

Practice Exam 2
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1) $P = \int_x^\infty e^{-x^2}\,dx \Rightarrow x = 0.5/0.098 = 5.1$

$= 8.97 \times 10^{-7}$

2) (a) Bipolar pulses are "neutral" with respect to current flow through a circuit. Unipolar pulses require a net flow of current through the circuit whence they pass.

(b) The "zero crossing" point of a series of bipolar pulses is constant with respect to the time of origin of the pulse.

3) (a) negative high voltage bases produce the output pulse at ground and allow "DC" coupling of the pulse into subsequent electronic circuits

(b) positive high voltage puts the photocathode at ground potential whereas negative HV puts the photocathode at negative high voltage and a large capacitive charge can develop across the glass surface on which the photocathode is plated (which can be dangerous if not properly designed.

4)

(a) electric field $\mathcal{E} = \frac{900\,V}{25\,cm} = 36\,V/cm$, $\mu = 2\times10^4 \frac{cm^2}{Vs}\,\frac{760\,torr}{200\,torr} = 7.6\times10^4 \frac{cm^2}{Vs}$

electron velocity $v = \mu\mathcal{E} = 7.6\times10^4 \frac{cm^2}{Vs} \times \frac{36\,V}{cm} = 2.74\times10^6\,cm/s$

(non relativistic) $t = \frac{x}{v} = \frac{25\,cm}{2} \Big/ 2.74\times10^6\,cm/s = 4.6\times10^{-6}\,sec$

(b) $\sigma_x = 300\,\mu m$, $x = vt \rightarrow \frac{\sigma_x}{x} = \frac{\sigma_t}{t}$

(continue)

4 (b) con't $\frac{\sigma_x}{x} = \frac{\sigma_t}{t} \rightarrow \frac{300\times10^{-6}\,m}{12.5\times10^{-2}\,m} = \frac{\sigma_t}{4.6\times10^{-6}\,s}$

Total ~~[illegible]~~ $\sigma_t = 0.0024 \times 4.6\times10^{-6}\,s = 1.1\times10^{-8}\,s$ or 11 ns

(c) σ_t^{DRIFT} from CFD against scint $\sigma_t^{SCINT} = 0.25$ ns

$$(\sigma_t^{TOTAL})^2 = (\sigma_t^{Drift})^2 + (\sigma_t^{SCINT})^2$$

$$\sigma_t^{Drift} = \left[(\sigma_t^{TOTAL})^2 - (\sigma_t^{SCINT})^2\right]^{1/2} = \left[11^2 - 0.25^2\right]^{1/2} \simeq 11$$

in CFD $\sigma_t = \text{risetime}/_{S/N} = 11\,ns = \frac{100\,ns}{S/N} \rightarrow S/N = \frac{100}{11} = 9.09$

so $S/N = 9.09$, noise $\simeq \frac{S}{9.09} \simeq \frac{1.00\,V}{9.09} = 0.11\,V$ (pretty easy to get this)

(d) $$\ln M = \frac{V}{\ln(b/a)} \frac{\ln 2}{\Delta V}\left[\ln\left(\frac{V}{K\,p\,a\,\ln(b/a)}\right)\right]$$

a = 25 μm/2

b = 10. mm/2

p = 200 torr

P-10 $\Delta V = 23.6\,V$ Table 6.1

$K = 4.8\times10^4 \frac{V}{cm\,atm}$

$$\ln M = \frac{1000\,V}{\underbrace{\ln\left(\frac{10^{-2}\,m}{25\times10^{-6}\,m}\right)}_{6.685}} \frac{\ln 2}{23.6\,V}\left[\ln \frac{1000\,V}{4.8\times10^4 \frac{V}{cm\,atm}\, \frac{25}{2}\times10^{-4}\,cm \left(\frac{200}{760}\right) \ln\left(\frac{10^{-2}}{25\times10^{-6}}\right)}\right]$$

$\ln M = 4.384 \ln[4.393] = 9.88 \rightsquigarrow M = 19{,}500.$

(e) N_{IP} (in Gas) $= \frac{15\times10^{6}\,eV}{26\,eV/_{IP}}$ Table 6.2 $= 5.77\times10^5$

$\left[N_{wire} = M * N_{IP} = 19{,}500 \times 5.77\times10^5 = 1.13\times10^{10} \text{ (wow)}\right]$

from Lecture $\left(\frac{\sigma_Q}{Q}\right)^2 = \left(\frac{F}{N_{IP}}\right) + \frac{1}{N_{IP}} \rightarrow \left(\frac{\sigma_Q}{Q}\right)^2 = \frac{1.21}{5.77\times10^5} = 2.1\times10^{-6}$

$\frac{\sigma_Q}{Q} = 1.44\times10^{-3}$

$R = 2.354\left(\frac{\sigma_Q}{Q}\right) = 3.41\times10^{-3}$

(f) The signal is created by the motion of the cations away from the central wire. The induced signal is readout on the stripes.

Bevington

APPENDIX C

GRAPHS AND TABLES

C-1 GAUSSIAN PROBABILITY DISTRIBUTION

The probability function $P_G(x,\mu,\sigma)$ for the Gaussian or normal error distribution is given by

$$P_G(x,\mu,\sigma) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]$$

If measurements of a quantity x are distributed in this manner around a mean μ with a standard deviation σ, the probability $dP_G(x,\mu,\sigma)$ for observing a value of x, within an infinitesimally small interval dx, in a random sample measurement is given by

$$dP_G(x,\mu,\sigma) = P_G(x,\mu,\sigma)\,dx$$

Values of the probability function $P_G(x,\mu,\sigma)$ are tabulated in Table C-1 as a function of the dimensionless deviation

$$z = |x - \mu|/\sigma$$

for z ranging from 0.0 to 3.0 in increments of 0.01 and up to 5.9 in increments of 0.1. These values were calculated with the subroutine PGAUSS of Program 3-4. This function is graphed on a semilogarithmic scale as a function of z in Figure C-1.

The function which is tabulated and graphed is $P_G(z,0,1)$ which gives the probability that $x = \mu \pm z\sigma$. It is the curve of Figure 3-5 tabulated only for positive values of z as indicated.

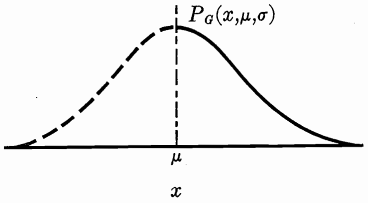

Table C-1 Gaussian probability distribution. The Gaussian or normal error distribution $P_G(x,\mu,\sigma)$ vs. $z = |x - \mu|/\sigma$

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.39894	.39892	.39886	.39876	.39862	.39844	.39822	.39797	.39767	.39733
0.1	.39695	.39654	.39608	.39559	.39505	.39448	.39387	.39322	.39253	.39181
0.2	.39104	.39024	.38940	.38853	.38762	.38667	.38568	.38466	.38361	.38251
0.3	.38139	.38023	.37903	.37780	.37654	.37524	.37391	.37255	.37115	.36973
0.4	.36827	.36678	.36526	.36371	.36213	.36053	.35889	.35723	.35553	.35381
0.5	.35207	.35029	.34849	.34667	.34482	.34294	.34105	.33912	.33718	.33521
0.6	.33322	.33121	.32918	.32713	.32506	.32297	.32086	.31874	.31659	.31443
0.7	.31225	.31006	.30785	.30563	.30339	.30114	.29887	.29659	.29431	.29200
0.8	.28969	.28737	.28504	.28269	.28034	.27799	.27562	.27324	.27086	.26848
0.9	.26609	.26369	.26129	.25888	.25647	.25406	.25164	.24923	.24681	.24439
1.0	.24197	.23955	.23713	.23471	.23230	.22988	.22747	.22506	.22266	.22025
1.1	.21785	.21546	.21307	.21069	.20831	.20594	.20357	.20122	.19887	.19652
1.2	.19419	.19186	.18955	.18724	.18494	.18265	.18038	.17811	.17585	.17361
1.3	.17137	.16915	.16694	.16475	.16256	.16039	.15823	.15609	.15395	.15184
1.4	.14973	.14764	.14557	.14351	.14147	.13944	.13742	.13543	.13344	.13148
1.5	.12952	.12759	.12567	.12377	.12189	.12002	.11816	.11633	.11451	.11271
1.6	.11093	.10916	.10741	.10568	.10397	.10227	.10059	.09893	.09729	.09567
1.7	.09406	.09247	.09090	.08934	.08780	.08629	.08478	.08330	.08184	.08039
1.8	.07896	.07755	.07615	.07477	.07342	.07207	.07075	.06944	.06815	.06688
1.9	.06562	.06439	.06316	.06196	.06077	.05960	.05845	.05731	.05619	.05509
2.0	.05400	.05293	.05187	.05083	.04981	.04880	.04781	.04683	.04587	.04492
2.1	.04399	.04307	.04217	.04129	.04041	.03956	.03871	.03788	.03707	.03627
2.2	.03548	.03471	.03395	.03320	.03247	.03175	.03104	.03034	.02966	.02899
2.3	.02833	.02769	.02705	.02643	.02582	.02522	.02464	.02406	.02350	.02294
2.4	.02240	.02187	.02135	.02083	.02033	.01984	.01936	.01889	.01843	.01798
2.5	.01753	.01710	.01667	.01626	.01585	.01545	.01506	.01468	.01431	.01394
2.6	.01359	.01324	.01290	.01256	.01224	.01192	.01160	.01130	.01100	.01071
2.7	.01042	.01015	.00987	.00961	.00935	.00910	.00885	.00861	.00837	.00814
2.8	.00792	.00770	.00749	.00728	.00707	.00688	.00668	.00649	.00631	.00613
2.9	.00595	.00578	.00562	.00546	.00530	.00514	.00500	.00485	.00471	.00457

	.00	.10	.20	.30	.40
3.0	.0044318	.0032668	.0023841	.0017226	.0012322
3.5	.00087269	.00061191	.00042479	.00029195	.00019866
4.0	.00013383	.000089264	.000058945	.000038536	.000024943
4.5	.000015984	.000010141	.0000063701	.0000039615	.0000024391
5.0	.0000014868	.00000089730	.00000053614	.00000031716	.00000018575
5.5	.00000010771	.00000006183	.00000003514	.00000001978	.00000001102