QUIZ 5 SOLUTION
CE 412/512 Hydrology - Spring 2013

Quiz is closed book and closed notes. For all problems, **write the equations used**, **show your calculations**, **include units**, and **box your answers**.

1. *(40 pts)* A levee has been built to protect a development located in the floodplains until a major flood control project can be completed. The levee was built to protect the development from a 10-year flood. The flood control project will take 5 years to complete. What is the probability that the levee will be overtopped:

Equations: $P = \frac{1}{T}$ $\quad Risk = 1 - \left(1 - \frac{1}{T}\right)^n$ $\quad Reliability = 1 - Risk$

$$P(x) = C_x^n * P^x(1-P)^{n-x} = \frac{n!}{(n-x)! * x!} * P^x(1-P)^{n-x}$$

a. At least once during the 5-year project?

$$Risk = 1 - \left(1 - \frac{1}{T}\right)^n$$

$$= 1 - \left(1 - \frac{1}{10}\right)^5 = 1 - 0.5905 = \mathbf{0.4095}$$

b. Not at all during the project?

$$Reliability = 1 - Risk$$

$$= 1 - 0.4095 = \mathbf{0.5905}$$

c. In the first year only?

$$= P(1-P)^{n-1}$$

$$= \frac{1}{T}\left(1 - \frac{1}{T}\right)^{n-1}$$

$$= (0.1) * (1 - 0.1)^4$$

$$= \mathbf{0.0656}$$

d. Exactly three times during the 5-year project?

$$P(x) = C_x^n * P^x(1-P)^{n-x} = \frac{n!}{(n-x)! * x!} * P^x(1-P)^{n-x}$$

$$= \frac{5!}{2! * 3!} * P^3(1-P)^2 = \frac{5!}{2! * 3!} * \left(\frac{1}{10}\right)^3 \left(1 - \frac{1}{10}\right)^2 = \mathbf{0.0081} = \mathbf{0.81\%}$$

2. *(30 pts)* Given the data below for the Sandy River, find the following. Assume the data are normally distributed.

	Data (cfs)
Mean	15,682
Standard Deviation	4,612
Station Skewness	1.127

Equations: $F(z) = 1 - \left(\frac{1}{T}\right)$ $\quad Q = \mu + z\sigma$

See Normal Distribution Tables on the following page.

a. Peak flow of the 50-year flood.

$$F(z) = 1 - \left(\frac{1}{T}\right) = 1 - \left(\frac{1}{50}\right) = 0.98$$

From Table D-1 and by interpolation → $z = 2.054$

$$Q = \mu + z\sigma = 15{,}682 + 2.054(4{,}612) = \mathbf{25,155}\ \boldsymbol{cfs}$$

b. Probability that a flood will be less than or equal to 5,000 cfs.

$$Q = \mu + z\sigma$$

$$5{,}000 = 15{,}682 + z(4612)$$

$$z = -2.316$$

From Table D-1 → $F(2.316) = 0.9897$

$$F(-z) = 1 - F(z) = 1 - 0.9897 = 0.0103$$

$$Probability\ \leq 5{,}000\ cfs = \mathbf{0.0103} = \mathbf{1.03}\%$$

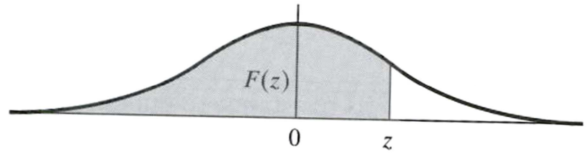
c. Return period of the 5,000 cfs flood.

$$T = \frac{1}{1 - F(z)}$$

$$T = \frac{1}{1 - 0.0102}$$

$$T = \mathbf{1.01}\ \boldsymbol{years}$$

Table D–1. Cumulative Normal Distribution*



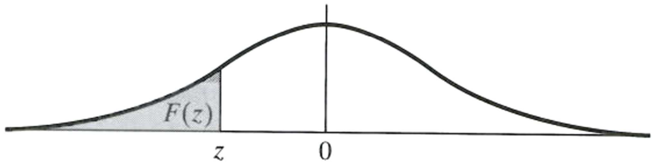
$$F(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-z^2/2}\, dz$$

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

(continued)

*For more extensive tables, see National Bureau of Standards, *Tables of Normal Probability Functions,* Washington, D.C., U.S. Government Printing Office, 1953 (Applied Mathematics Series 23). Note that they show

Table D–2. Percentiles of the Normal Distribution*

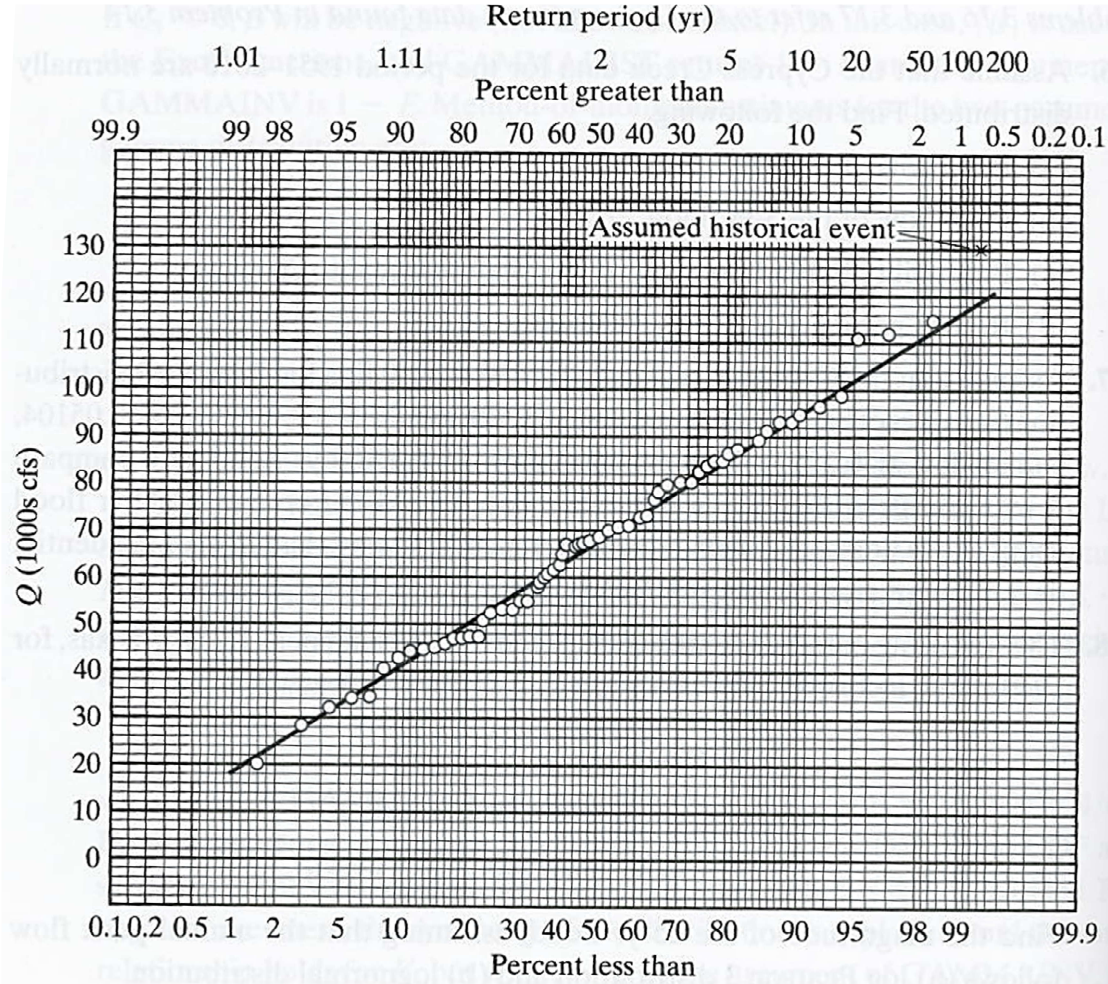


$$F(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-z^2/2}\, dz$$

F(z)	z	F(z)	z
.0001	−3.719	.500	.000
.0005	−3.291	.550	.126
.001	−3.090	.600	.253
.002	−2.878	.650	.385
.005	−2.576	.700	.524
.010	−2.326	.750	.674
.020	−2.054	.800	.842
.025	−1.960	.850	1.036
.040	−1.751	.900	1.282
.050	−1.645	.950	1.645
.100	−1.282	.960	1.751
.150	−1.036	.975	1.960
.200	−.842	.980	2.054
.250	−.674	.990	2.326
.300	−.524	.995	2.576
.350	−.385	.998	2.878
.400	−.253	.999	3.090
.450	−.126	.9995	3.291
.500	.000	.9999	3.719

*For a normally distributed variable x, we have

3. *(20 pts)* Given the normal probability plot for Kentucky River data below, use the fitted line to determine:



a. What is the 10-yr flow?

94,000 cfs

b. What is the return period of a flow of 30,000 cfs?

Interpolate between 1.01 and 1.11 → **1.04 years**

Or F(x) = 3.8% = 0.038

$$T = \frac{1}{1 - F(z)} = \frac{1}{0.962} = \mathbf{1.04\ \mathit{years}}$$

c. What is the probability (in percent) that the annual peak discharge will be between 40,000 cfs and 100,000 cfs?

94 % – 10 % = **84 %**

4. *(10 pts)* Briefly describe (a couple of sentences) what caused the Missoula floods?