UNIVERSITY OF JORDAN
CHEMICAL ENGINEERING DEPARTMENT

0905331 – PROCESS MODELING BY STATISTICAL METHODS

Name	
University ID	

Course **0905331 – PROCESS MODELING BY STATISTICAL METHODS**	
Exam	Midterm
Date	Wednesday, 28/11/2007
Time	60 minutes closed book part with **A4 sheet** allowed
Instructor	Dr. Ali Al-matar

Problem	Full Mark	Mark
1	25	
2	25	
3	25	
4	25	
Total	**100**	

وقّع على القسَم التالي المتعلق بالغش الأكاديمي:

اقسم بالله أنني لم اغش في هذا الامتحان ولم أساعد أي شخص على الغش سواءً لمنفعتي الشخصية أو لمنفعة الآخرين، وعلى هذا أوقّع.

التوقيع:

1. **(25 marks)** An extrusion die is used to produce aluminum rods. Specifications are given for the length and the diameter of the rods. For each rod, the length is classified as too short, too long, or OK, and the diameter is classified as too thin, too thick, or OK. In a population of 1000 rods, the number of rods in each class is as follows:

	Diameter		
Length	**Too thin**	**OK**	**Too thick**
Too short	**10**	**3**	**5**
OK	**38**	**900**	**4**
Too long	**2**	**25**	**13**

a) A rod is sampled at random from this population. What is the probability that it is too short?

b) A rod is sampled at random from this population. What is the probability that it is either too short or too thick?

c) Compute the conditional probability P(diameter OK |length too long). Is this the same as the unconditional probability P(diameter OK)?

d) A rod is sampled at random from this population; find P(too long) and P(too long |too thin). Are these probabilities different?

2. (25 marks) A certain radioactive mass emits alpha particles from time to time. The time between emissions, in seconds is, is random, with probability density function

$$f(x) = \begin{cases} 0.1e^{-0.1x} & x > 0 \\ 0 & x \leq 0 \end{cases}$$

a) Find the expected value of time between emissions.
b) Find the median time between emissions.
c) Find the 60^{th} percentile of the times.

3. **(25 marks)** In oil exploration, the probability of an oil strike in the North Sea is 1 in 500 drillings. What is the probability of having exactly 3 oil-producing wells in 1000 explorations?

4. **(25 marks)** A process manufactures ball bearings whose diameters are normally distributed with mean 2.505 cm and standard deviation 0.008 cm. Specifications call for the diameter to be in the interval 2.5 ± 0.01 cm.

   a) What proportion of the ball bearings will meet the specifications?

   b) The process can be recalibrated so that the mean will equal 2.5 cm, the center of the specification interval. The standard deviation of the process remains 0.008 cm. What proportion of the ball bearings will meet the specifications?

   c) Assume that the process has been calibrated so that the mean diameter is now 2.5 cm. To what value must the standard deviation be lowered so that 95% of the diameters will meet the specifications?

Table 1 Cumulative Standard Normal Distribution (Excerpted from Montgomery and Runger)

z	**-0.09**	**-0.08**	**-0.07**	**-0.06**	**-0.05**	**-0.04**	**-0.03**	**-0.02**	**0.01**	**0.00**
-3.9	0.000033	0.000034	0.000036	0.000037	0.000039	0.000041	0.000042	0.000044	0.000046	0.000048
-3.0	0.001001	0.001035	0.001070	0.001107	0.001144	0.001183	0.001223	0.001264	0.001306	0.001350
-2.0	0.018309	0.018763	0.019226	0.019699	0.020182	0.020675	0.021178	0.021692	0.022216	0.022750
-1.9	0.023295	0.023852	0.024419	0.024998	0.025588	0.026190	0.026803	0.027429	0.028067	0.028717
-1.8	0.029379	0.030054	0.030742	0.031443	0.032157	0.032884	0.033625	0.034379	0.035148	0.035930
-1.3	0.082264	0.083793	0.085343	0.086915	0.088508	0.090123	0.091759	0.093418	0.095098	0.096801
-1.2	0.098525	0.100273	0.102042	0.103835	0.105650	0.107488	0.109349	0.111233	0.113140	0.115070
-1.1	0.117023	0.119000	0.121001	0.123024	0.125072	0.127143	0.129238	0.131357	0.133500	0.135666
-1.0	0.137857	0.140071	0.142310	0.144572	0.146859	0.149170	0.151505	0.153864	0.156248	0.158655
0.0	0.464144	0.468119	0.472097	0.476078	0.480061	0.484047	0.488033	0.492022	0.496011	0.500000

z	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0	0.500000	0.503989	0.507978	0.511967	0.515953	0.519939	0.532922	0.527903	0.531881	0.535856
0.5	0.691462	0.694974	0.698468	0.701944	0.705401	0.708840	0.712260	0.715661	0.719043	0.722405
0.6	0.725747	0.729069	0.732371	0.735653	0.738914	0.742154	0.745373	0.748571	0.751748	0.754903
1.2	0.884930	0.886860	0.888767	0.890651	0.892512	0.894350	0.896165	0.897958	0.899727	0.901475
1.9	0.971283	0.971933	0.972571	0.973197	0.973810	0.974412	0.975002	0.975581	0.976148	0.976705
2	0.977250	0.977784	0.978308	0.978822	0.979325	0.979818	0.980301	0.980774	0.981237	0.981691
3	0.998650	0.998694	0.998736	0.998777	0.998817	0.998856	0.998893	0.998930	0.998965	0.998999
3.9	0.999952	0.999954	0.999956	0.999958	0.999959	0.999961	0.999963	0.999964	0.999966	0.999967