

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

Diploma In Quality Assurance: December Examinations 1999

IE878: Statistical Quality Control I

Dr. Wright,
Prof. O'Kelly,
Dr. Sheil.

Attempt *three* questions.

Time allowed: **2 hours**

Cambridge Elementary Statistical Tables available.
Statistical Formula Sheet appended.

Q.1

In its raw form, data is rarely useful - typically tabular, graphical and numerical summaries are produced. The data below represent the numbers of knitting flaws found in a sample of 80 woolen sweaters drawn from the output of 2 similar knitting machines, producing such sweaters.

Develop appropriate summaries of this data and comment on your findings. [15 marks]

What, if any, additional information would you like to have at your disposal? [2 marks]

1	0	10	2	1	0	10	0	9
0	1	0	0	8	1	0	2	0
0	0	1	10	0	9	4	0	1
0	3	0	1	10	0	4	0	1
0	0	3	10	0	2	0	0	0
3	10	0	1	9	1	12	0	0
1	0	0	0	0	3	2	0	1
0	0	1	0	0	2	10	0	1
0	0	0	1	0	0	0	9	0

Q.2 Attempt any *three* of (i), (ii), (iii), (iv), (v) below.

(i) Find the expected value and variance of the following probability distribution:

x	3	4	5	6	7	8	9
p(x)	.40	.25	.15	.11	.07	.01	.01

[5 marks]

(ii) A random sample of 20 items is drawn from a stable process known to produce 5% defective items.

(a) What is the probability that 3 of the items are defective? [2 marks]

(b) How many defective items would you *expect* the sample to contain? [1 mark]

(c) Find the probability that the sample has more defectives than expected [3 marks]

(iii) A fish processing company packs mackerel in 150g cans. Stated policy requires that at least 98% of cans labelled 150g, contain (at least) 150 grammes of fish. The standard deviation of fill weight is known to be 5 grammes and the canning process is stable i.e. capable of holding to a fixed target/average weight.

(a) When the target weight is 156g, what proportion of cans weigh less than 150 grammes? Assume that fill weight is 'normally distributed'. [3 marks]

(b) Where should target weight be set in order to comply with stated policy? [3 marks]

(iv) Consider a continuous random variable X with mean μ and variance σ^2 .

If $Z = \frac{X - \mu}{\sigma}$, prove that $E(Z) = 0$ and $\text{Var}(Z) = 1$. [2 x 3 marks]

(v) Using standard notation, define *conditional probability*, *independent events* [2 marks]

An electronic circuit containing a diode and 2 transistors 'works' if the diode and at least one transistor work. Let D , T_1 and T_2 represent the events that the diode and transistors 1 and 2, respectively, operate correctly. If W is the event that the circuit operates correctly, express W in terms of D , T_1 and T_2 [3 marks]

Q.3

Write a short technical essay to demonstrate your understanding of basic concepts involved in hypothesis testing.

[6 marks]

Company A claims that the machine components which it manufactures are superior to (last longer than) those produced by a competitor - Company B. To test this claim, samples of components originating in both companies were subjected to accelerated life testing. The sample data has been summarised as follows:

Company	No. tested	Average lifetime(\bar{x})	Sample Variance(s^2)
A	40	307	27
B	36	282	30

- (a) Is it reasonable to assume that variation in component lifetime is the same for the two component types? Perform an appropriate test. [4 marks]
- (b) Test whether the claim made by Company A is justified. [7 marks]

Q.4

(i) The number of batches of product arriving daily at a repair station is assumed to follow a Poisson distribution with parameter/mean value $\lambda = 2$. Calculate the probability that on a given day:

- (a) 1 batch arrives; [1 mark]
- (b) 4 or more batches arrive. [3 marks]

(ii) The number of batches arriving daily at the inspection station of part (i) above was noted for a period of 100 days. The counts obtained were then summarized as follows:

No. batches per day	0	1	2	3	≥ 4
Frequency(no. of days)	11	30	36	19	4

Use a *Chi Square Goodness-of-Fit Test* to determine if this data is consistent with the assumption made in (i) above.

[12 marks]

Q.5

Describe the circumstances under which the following linear equation is employed:

$$y_{ijk} = \mu + (A)_i + (B)_j + (AB)_{ij} + \varepsilon_{ijk} : i=1, \dots, a ; j=1, \dots, b ; k=1, \dots, n$$

[2 marks]

Write out the general form of the ANOVA-table used in this case.

[3 marks]

Now, present and analyze a numerical example of your choice, to demonstrate your ability to complete and interpret such a table.

[10 marks]

State two major assumptions underlying your analysis.

[2 marks]