**Q1:** In a NiCd battery, a fully charged cell is composed of Nickelic Hydroxide. Nickel is an element that has multiple oxidation stats that is usually found in the following states:

|  |  |
| --- | --- |
| **Nickel charge** | **Proportions found** |
| 0 | 0.17 |
| +2 | 0.35 |
| +3 | 0.33 |
| +4 | 0.15 |

1. What is the probability that a cell has at least one of the positive nickel charged options?
2. What is the probability that a cell is not composed of a positive nickel charge greater than +3?

**Q2:** The following table summarizes the analysis of samples of galvanized steel for coating weight and surface roughness :

|  |  |
| --- | --- |
|  | Coating weight |
| high | low |
| surface | high  | 12 | 16 |
| roughness | low | 88 | 34 |

1. If the coating weight of a sample is high, what is the probability that the surface roughness is high?
2. If the surface roughness of a sample is high, what is the probability that the coating weight is high?
3. If the surface roughness of a sample is low, what is the probability that the coating weight is low?

**Q3:** An e-mail message can travel through one of two server routes. The probability of transmission error in each of the servers and the proportion of message that travel each route are shown in the following table. Assume that the servers are independent.

|  |  |  |
| --- | --- | --- |
|  | Percent ofmessages | **Probability of error** |
| Server1 | Server2 | Server3 | Server4 |
| Route1 | 30 | 0.01 | 0.015 |  |  |
| Route2 | 70 |  |  | 0.02 | 0.003 |

1. What is the probability that a message will arrive without error?
2. If a message arrives in error, what is the probability it was sent through route 1 ?

**Q4:** An article in Information Security Technical Report, “Malicious software-past, present and future.” (2004,Vol. 9, pp. 6-18) provided the following data on the top ten malicious software instances for 2002. The clear leader in the number of registered incidences for the year 2002 was the Internet worm “Klez,” and it is still one of the most widespread threats. This virus was first detected on 26 October 2001, and it has held the top sport among malicious software for the longest period in the history of virology.

|  |  |  |
| --- | --- | --- |
| **Place** | **Name** | **% Instances** |
| 1 | I-Worm.Klez | 63.22% |
| 2 | I-Worm.Lentin | 20.52% |
| 3 | I-Worm.Tanatos | 2.09% |
| 4 | I-Worm.BadtransII | 1.31% |
| 5 | Macro.Word97.Thus | 1.19% |
| 6 | I-Worm.Hybris | 0.60% |
| 7 | I-Worm.Bridex | 0.32% |
| 8 | I-Worm.Magistr | 0.30% |
| 9 | Win95.CIH | 0.27% |
| 10 | I-Worm.Sircam | 0.24% |

The 10 most widespread malicious programs for 2002 (Source-Kaspersky Labs).

Suppose that 20 malicious software instances are reported.

Assume that the malicious sources can be assumed to be independent.

1. What is the probability at least one instance is “Klez”?
2. What is the probability that three or more instances are “Klez”?
3. What is the mean and standard deviation of the number of “Klez” instances among the 20 reported?

**Q5:** Assume that each of your calls to popular radio station has a probability of 0.02 of connecting, that is, of not obtaining a busy signal. Assume that your calls are independent

1. What is the probability that your first call that connects is your tenth call?
2. What is the probability that it requires more than five calls for you to connect?
3. What is the mean number if calls needed to connect?

**Q6:** The probability that an eagle kills a jackrabbit in a day of hunting is 10%. Assume that results are independent between days.

1. What is the distribution of the number of days until a successful jackrabbit hunt?
2. What is the probability that the eagle must wait 5 days for its first successful hunt?
3. What is the expected number of days until a successful hunt?

**Q7:** Integration by parts is required. The probability density function for the diameter of a drilled hole in millimeters is 10$e^{-10(x-5)}$ for x>5 mm. although the target diameter is 5 millimeters, vibrations, tool wear, and other nuisances produce diameters larger than 5 millimeters.

1. Determine the mean and variance of the diameter of the holes.
2. Determine the probability that a diameter exceed 5.1 millimeters.

**Q8:** The fill volume of an automated filling machine used for filling cans of carbonated beverage is normally distributed with a mean of 12.4 fluid ounces and a standard deviation of 0.1 fluid ounces.

1. What is the probability a fill volume is less than 12 fluid ounces?
2. If all cans less than 12.1 or greater than 12.6 ounces are scrapped, what proportion of cans is scrapped?
3. Determine specifications that are symmetric about the mean that include 99% of all cans.

**Q9:** Based on the number of voids, a ferrite slab is classified as either high, medium, or low. Historically, 5% of the slabs are classified as high, 85% as medium, and 10% as low. A sample of 20 slabs is selected for testing. Let X, Y and Z denote the number of slabs that are independently classified as high, medium, and low, respectively.

1. What are the name and the values of the parameters of the joint probability distribution of X, Y and Z?
2. What is the range of the joint probability distribution of X, Y, Z?
3. What is the name and the values of the parameters of the marginal probability distribution of X ?
4. E(X) and V(X).

Determine the following:

1. P(X = 1, Y = 17, Z = 3)
2. P(X ≤ 1, Y = 17, Z = 3)
3. P(X ≤ 1)
4. E(Y)
5. P(X = 2, Z = 3|Y = 17)
6. P(X = 2|Y = 17)
7. E(X|Y = 17)

**Q10:** Ā1 and $S1^{2} $are the sample mean and sample variance from a population with mean µ1 and variance $σ1^{2}$. Similarly, Ā2 and $S2^{2}$ are the sample mean and sample variance from a second independent population with mean µ2 and variance $σ2^{2}$. The sample sizes are n1 and n2, respectively.

1. Show that Ā1-Ā2 is an unbiased estimator of µ1-µ2.
2. Find the standard error of Ā1-Ā2. How could you estimate the standard error?
3. Suppose that both population have the same variance; that is, $σ1^{2 }$=$σ2^{2}$=$σ^{2}$. Show that

$Sp^{2}$= $\frac{\left(n1-n2\right)S1^{2}+ (n2-1)S2^{2}}{n1+n2-2}$

Is an unbiased estimator of $σ^{2}$.