

**LS4202:Biostatistics. Mid-Semester Test.**

**Date:** February 22, 2010. 3:30 - 5:00 PM, **Marks** = 20

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**Section I: Answer all questions. Marks:  $2 \times 4 = 8$**

1. What is a *random variable*? Illustrate with an example.
2. Suppose you are to take clinical measurements on  $n_1$  adult men,  $n_2$  adult women, and  $n_3$  children. You make them stand beside each other in a single row to take measurements. In how many different ways can you arrange them so that individuals of a given type are contiguous? (Note: The order of individuals matters).
3. Consider two independent rolls of a fair 6-sided die. We define three events,  $A = \{1\text{st roll is } 1, 2, \text{ or } 3\}$ ,  $B = \{1\text{st roll is } 3, 4, \text{ or } 5\}$ , and  $C = \{\text{the sum of the two rolls is } 9\}$ . Are the events  $A$ ,  $B$ , and  $C$  independent?
4. A death was recorded in a hospital ICU where three kinds ( $A$ ,  $B$ ,  $C$ ) of complications could have been responsible, but it is unclear which occurred. It is known that cause  $A$  is responsible for 50% of such deaths and causes  $B$  and  $C$  for 25% each under similar circumstances. What is the probability that the death occurred due to cause  $A$ ? Illustrate the probability rule that you will use to solve this.

**Section II: Answer all questions. Marks:  $3 \times 4 = 12$**

5. From past experience, the epicentres of 10% of the earthquakes are within 50 km from a nuclear power plant. Now, consider a sequence of 10 such earthquakes and let  $X$  be the number of earthquakes whose epicenters are within 50 km from the nuclear power plant. Assume that the distances associated with different earthquakes are independent random variables and that all the earthquakes have the same probabilities of having their epicenters at distances within 50 km. Then, what is the probability mass function (pmf) of  $X$ ? And what is the probability that none of the 10 earthquakes will occur within 50 km from the power point?
6. If  $X$  and  $Y$  are two independent random variables, then consider a linear function of  $X$  and  $Y$  such that  $Z = aX - bY$  (where,  $a$  and  $b$  are constants). Show that the variance of  $Z$  is given by  $Var(Z) = a^2Var(X) + b^2Var(Y)$ .
7. An oil company conducts a geological study that indicates that an exploratory oil well should have a 20% chance of striking oil. Suppose that the company is drilling a series of such wells and each drilling is an independent event. What is the probability that the first strike comes on the third well drilled? What is the probability that the third strike comes on the seventh well drilled?
8. Suppose that there are 5 storms per year on average. Assume that the occurrence of such storms is a Poisson process. Then, what is the probability that the time between two consecutive storms will be less than one month? (Hint: Consider that  $T$  is the time interval between two consecutive events, and use the cumulative distribution function of  $T$ ).

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