MIDDLE EAST TECHNICAL UNIVERSITY

FACULTY OF ENGINEERING

CE 204 UNCERTAINTY and DATA ANALYSIS

Spring Semester 2013-14

Homework 1- Date Due: March 17th, 2014 Monday till 16.00

IMPORTANT NOTICE:

- ***You are allowed to collaborate with other students (or ask questions to your assistants/ instructors) on homework provided that you stay away from plagiarizing (according to dictionaries "to plagiarize" means to steal and pass off ideas and/or words/ solutions of another as one's own without citing the source). That is, collaboration is accepted if you write and give your own solutions. If you are caught on plagiarizing or cheating by handing in "too similar" homework, you will be graded by zero on this homework.***
- ***For late submission of homework, there will be 5 points of deduction for every late day and no homework will be accepted after a week from the due date.***
- ***You are to hand in answers to all questions but you will all be graded on only one randomly chosen answer.***

1. In your own words please explain the following and give at least two examples to clarify your explanation for each case.

a) **Type and nature of uncertainties**

b) **Reducible uncertainties**

c) **Frequency definition of probability**

d) **Statistically (or stochastically) independent events**

e) **Mutually exclusive and exhaustive events.**

f) **Significance of Bayes' Theorem (Law).**

2. The three major loadings on a nuclear power plant, as far as safety is concerned, are those due to severe earthquakes (**E**), loss of coolant accident (**L**) and thermal transients (**T**). For a typical plant the chances of occurrence of E, L and T in a given year are 0.0012, 0.0022 and 0.0018, respectively. Also severe earthquakes sometimes cause L due to pipe breaks; it is estimated that that the chance of L increases to 10% if severe earthquakes occur in the same year. T is assumed to be independent of both E and L.

a) What is the probability that in a given year all three types of loadings will occur?

b) If at least one of the major loadings occurs, the plant has to be shut down for a period of time and the utility company will suffer some loss of revenue due to power outage. What is the probability of this loss in a given year?

c) If the utility company incurs this loss of revenue in a given year, what is the probability that severe earthquakes occurred that year?

3. Geological exploration was conducted to investigate the joints and potential slip surfaces that exist in the rock strata before a tunnel construction. For economic reasons, only portions of the strata are explored and the measurements recorded by the instruments are not perfectly reliable. Thus the geologist can only conclude that the condition of the rock may be either highly fissured (H), medium fissured (M) , or slightly fissured (L) with relative likelihoods of 1 : 3 : 8. Based on this information, the engineer designs the tunnel and estimates that if the rock condition is L, the reliability of the proposed design is 99.5 %. However, if it turns out that the rock condition is M, the probability of failure will be doubled; similarly, if the rock condition is H, the probability of failure is 10 times that for condition L.

a) What is the expected reliability of the proposed tunnel design ?

b) A more reliable device is subsequently used to improve the prediction of rock condition. Its results indicate that a highly fissured condition for the rock around the tunnel is practically impossible, but it cannot give better information on the relative likelihood between rock conditions M and L. In light of this information, what would be the revised reliability of the proposed tunnel design?

c) If the tunnel collapsed, what should be the updated probabilities of M and L?

4. For a small municipality, the project of water supply to the region was built with two water reservoirs named COMMENCEMENT and TERMINATION, downstream. The project assures that reservoir COMMENCEMENT will supply all the water demand of the region. The reservoir TERMINATION will supply the necessary water to the region if reservoir COMMENCEMENT fails. The probability that the COMMENCEMENT will fail is 0.0012 and the probability that TERMINATION will fail while it is supplying water to the region is about 0.018. If you have a friend from this region and if he tells you that there is no water supply in the region , what is the probability that none of the reservoirs have failed?