NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ECONOMICS AND STATISTICAL ENGINEERING

STATISTICAL ENGINEERING PROGRAM

ES815 – STOCHASTIC PROCESSES

I. GENERAL INFORMATION

CODE	: ES815 Stochastic processes
SEMESTER	: 8
CREDITS	: 4
HOURS PER WEEK	: 5 (Theory, Practice)
PREREQUISITES	: ES411 – ES512
CONDITION	: Mandatory

II. COURSE INTRODUCTION

The course includes: Introduction. Preliminaries of probability theory. Probability spaces. Definition of stochastic process. Conditional hope. The Bernoulli process. The Poison process. Arrival times. Recurrence times. Decomposition of a Poisson process. Elements of the theory of renewal. Markov chains. Visits to a fixed state. Classification of states. Behavior in the limit. Recurring states and boundary probabilities. Periodic reports. Transient states. Matrix calculation. Applications to reliability. Glue systems. Maintenance. The process of branching in discrete time. Applications.

III. COURSE OUTCOMES

The student:

1. Explains and determines the probability of events in the Bernoulli process and its properties.
2. Understands and applies the theory of the Poisson Process to concrete problems of reality in particular to transportation problems.
3. Understands and applies Renewal Process theory to maintenance problems and other problems such as queuing systems. It organizes a data set and applies Markov chain theory to reliability, maintenance and environmental problems.
4. Organizes data for proper analysis and interpretation of reliability models and applies to specific cases of reality.

IV. LEARNING UNITS

1. THE BERNOULLI PROCESS / 10 HOUR

Preliminaries. Measure of probability. Probability space. Definition of a stochastic process. Classification of stochastic processes. The Bernoulli Process. Number of hits. Process with independent increments. Properties. Times of success. Properties. The Geometric distribution. Properties. Succession of independent random variables. Approximation to the Normal distribution.

2. THE POISSON PROCESS / 10 HOUR

The Poisson process, properties. Distribution of number of arrivals. Properties. Interlending times and waiting times. The distribution of interlending and waiting time. Conditional distribution of arrival times. Properties of the order statistics. Generalization of conditional distribution of arrival times. Non-homogenous Poisson process. Decomposition of a Poisson process. Poisson process overlap. Composite Poisson process. Applications.

3. RENEWAL THEORY / 10 HOUR

Elements of Renewal Theory. Convolutions. Laplace transform. Distribution of N(t). Renewal equation and generalizations. Limit theorems. Equation of Wald. Stopping time. Elementary Theorem of Renewal. Blackwell's Theorem. Key renewal theorem. Alternating renewal process. Prize renovation process. Excess of life and distribution of age. Applications.

4. MARKOV CHAINS / 10 HOURS

Markov chains. Definitions and examples. The random path. Equations of Chapman Kolmogorov. Classification of states. Communication of states. Properties. Irreducible Markov chains. Recurrent states. Average return times. Time of the first visit. Behavior in the limit. Recurring states and boundary probabilities. Periodic, transient and absorbent states, matrix calculations. Applications. Reliability, Tailings, Survival, Maintenance.

V. PRACTICAL AND LABORATORY EXPERIENCES

Laboratory 1: Application to a transport problem.
Laboratory 2: Application to a queuing system..

VI. METHODOLOGY

The course is developed in sessions of theory, practice and computer lab. In theory sessions, the teacher presents concepts, theorems and applications. In the practical sessions, various problems are solved and their solution is analyzed. In laboratory sessions, Matlab software is used to solve problems and analyze their solution. At the end of the course the student must develop and present an integrating project or monograph. In all the sessions the active participation of the student is promoted..

VII. GRADING SYSTEM

Evaluating System “G”. Calculating the final average: **PF = (EP + EF + PP) / 3**
Four graded practices are applied, the lowest grade is deleted.
EP: Mid-term Exam, EF: Final Exam, PP: Average of qualified practices.

VIII. BIBLIOGRAPHY

Roos Sheldon, Introduction to probability models edic 10, edit. Academic Press, 2010.
Barry L. Nelson, Stochstic Modeling, Mc Graw Hill, 1995.
Shunji Osaki, Stochastic System reliability modeling, edit World Scientific Publishing – Singapure, 1985.
Erhan Cinlar, Introduction to stochastic processes, edit Prentice Hall.1975.