NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ECONOMICS AND STATISTICAL ENGINEERING
STATISTICAL ENGINEERING PROGRAM

ES912 – COMPUTATIONAL STATISTICS

I. GENERAL INFORMATION

CODE	**:**	ES912 Computational Statistics
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory – Practice)
PREREQUISITES	**:**	150 credits
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

This theoretical-practical course encompasses the execution of applications in the computing lab under the instructor's guide, with the use of simulation-specialized software. The purpose of this course is to develop in students capabilities of modeling and business environment problems analysis using discrete simulation technology.

This course encompasses the following learning units: The first one deals with concepts and definitions of simulation, for this purpose concepts of systems, models and simulation are reviewed. The second one describes simulation support statistics, random number generation and random variables generation methods. The third one deals with the Statistic analysis of the simulation model output report, steady-state analysis, simulation projects design and development, business simulation applications and simulation cases study.

III. COURSE OUTCOMES

1. Study and identify the simulation models scope for solving real world problems.
2. Study mathematical foundation of the simulation models and identify concrete problematic situations that can be solved applying simulation models.
3. Implement number generators and random variables.
4. Use professional use software to model several systems.
5. Apply statistic concepts for the analysis of the simulation models output report.
6. Implement simulation projects based in a real case.

IV. LEARNING UNITS

1. CONCEPTS AND GENERATION OF NUMBERS AND RANDOM VARIABLES / 30 HOURS

Introduction to simulation / Concepts / real application of simulation in businesses / Pseudo-random numbers generation methods U(0,1) / Congruential method / Middle square method, variance test, shape test / Random variable generation method / inverse transform sampling / Uniform, exponential and other variables / Random variable generation using the convolution method / Normal variable generation.

2. CURVE FITTING / 12 HOURS

Continuous distributions / Discrete distributions / The chi-square goodness-of-fit test (Pearson's chi-square test / chi-square test for independence) / Kolgomorov-Smirnov' goodness-of-fit test.

3. NEXT EVENT TIME ADVANCE MECHANISM AND QUEUING THEORY / 18 HOURS
Next event time advance mechanism / Simulation of a Queuing system with a server / Average queuing delay / Average client queuing time / Basic queuing process / Birth and death process and structure / Nomenclature, Kendall-Lee notation / General Equations / Method of finite population with a server and many servers.

4. RESULTS ANALYSIS / 24 HOURS
Confidence interval / Central limit theorem / Understanding confidence intervals / Number of replicas determination / Confidence level / Number of replicas for several levels of confidence / Number of replicas for several sampling errors / Comparing alternatives / Test paired-t and Two simple test exercises / Results analysis – Non terminal simulation / Warm-up period for Steady-state simulation / methods to gather statistic observation / Subinterval method /Replication method / Generative Method (Cycle).

V. LABORATORIIES AND PRACTICAL EXOERIENCES:

- Implementation of the Montecarlo simulation in Excel environment.
- Random number generator
- Implementation of simulation models in a simulation software
- Use of statistic software for curve fitting
- Analysis of statistic results of simulation models

VI. METHODOLOGY

The deductive method will be applied in this aspect, from the definition to the example, from the rule to the principle, apart from the following procedures: synthesis, exemplification, verification, demonstration, application, checking and synopsis.

During the carrying out of the lab practical applications, students' active participation in the models implementation is encouraged. Throughout the course, students must develop a group project about simulation application with the instructor's advice.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = 0.3*EP + 0.3*EF + 0.2*PP + 0.2*PL

EP: Mid-Term Exam EF: Final Exam
PP: Quizzes' average (2) PL: Lab's average (2 labs + paper)/3

VIII. BIBLIOGRAPHY

1. **GARCIA DUNA EDUARDO, HERIBERTO GARCÍA REYES AND LEOPOLDO CÁRDENAS**
   Analysis of Systems with PROMODEL (Spanish)
   Pearson Education Editorial, 1st Edition, 2010

2. **GUASCH ANTONI, MIGUEL ÁNGEL PIERA, JOSEP CASANOVAS Y JAURME FIGUERAS**
   Modeling and Simulation, Application of logistic processes in manufacture and services
   Alfa y Omega Editorial, 1st Edition, 2005

3. **LAW, AVERILL M. AND DAVID KELTON**
   Simulation Modeling & Analysis
   McGraw-Hill, 3rd Edition, 2000