Course: Continuous/Discrete Modelling and Simulation

SSD MAT/07

in Master of Science on Modelling, Engineering and Strategies on Operations and Systems (STRATEGOS)

Credits: 10

5 Credits for Continuous Simulation, Cianci

5 Credits for Discrete Event Simulation, Bruzzone

Tentative Schedule:

Continuous Simulation, Cianci, 1st Semester, 1st Year

Discrete Event Simulation, Bruzzone, 2nd Semester, 1st Year

Tentative Schedule 1 Lecture of 5 hours in a row per week for 8 weeks to support Class Exercises and Lab Activities as well as International Seminars

Teachers:

Prof. Roberto Cianci & Agostino G. Bruzzone

Assistants for Exercises & Simulation Lab Experience:

Riccardo di Matteo, Kirill Sinelshchikov, Matteo Agresta, Giulio Franzinetti

Education Objectives:

Modeling and Simulation Fundamentals. Theory and Practice of Continuous Simulation and related Methodologies. Theory and Practice of Discrete Simulation and related Methodologies. Hybrid Simulation.

Course Program & Elements:

Classification Criteria for Modeling and Simulation.

The course presents the Principia of Continuous and Discrete Simulation; Dynamic Simulation and Time Management. Time Paced and Time Stepped Simulation.

Simulation in Continuous Domain and related Techniques and Methodologies. Numerical Methods for Continuous Simulation. Numerical Solutions of Differential Equations. Simulation and Partial Differential Equations. Analysis of Boundary Conditions. Continuous Simulation Software Programs. The importance of source terms in PDE related to the control mechanisms.

The course presents the partial differential equations of mathematical physics, elliptic, parabolic and hyperbolic in various theoretical and applicative framework. Formal and numerical solution techniques are discussed in examples.

Discrete Event Simulation. Statistical Models. Queueing Models. Random Number Generation and Monte Carlo Technique. Discrete Event Simulation Solutions, Tools and Languages.

Independent Variable & Controlled Variables. Verification and Validation Techniques and Methodologies. Analysis of Range of Validity. Analysis of Variance and Sensitivity Analysis.

The course includes examples of Continuous Simulation such as distribution of a chemical agent due to a terrorist act in different places (i.e. an open square and a subway station), conceptual modeling and simulation development; analysis of technical aspects and events to identify how simulation could be used to manage risk assessment and implementation of procedures for containment and remediation.

Discrete modelling is presented in an asymmetric framework where armed forces are involved; this investigation helps to better understand in military and civil environments, how to: intervene, detect, mitigate, coordinate efforts with civil defense.

Teaching Approach:

Frontal Lectures presenting Theory and Practical Application of Methodologies related to Modelling and Simulation for Complex Systems. Individual and Team Work Exercises in developing Conceptual Models and verifying, validating, tuning and conducting experiments on Simulators of Complex Systems.

Train the Students in Virtual Experiences within Simulation Labs by using directly the presented methodologies and techniques in realistic problems and case studies using M&S solutions

Evaluation and Final Exam:

Multiple Experiences carried out in Virtual Labs where the Students are evaluated on Simulation Exercises and Experiences, based on Individual and in team working by Collaborative and/or Competitive approach, representing Micro Projects devoted to address specific issues within realistic complex problems by using M&S (e.g. MISCHIEF, SIMCJOH, T-REX, DT)

Final Exam will be carried out by Oral Exam including review of the Simulation Exercises & Experiences and by requiring to demonstrate skills in conceptual modeling and simulation development

Timetable:

To be Finalized (TBF)

Time Zone:

CET (GMT+1)

Prerequisites:

The Course does not require specific prerequisites, being accessible to university students and including all the elements and references necessary for the Candidates; therefore basics know-how in engineering, mathematics, statistics and computer use could be useful to improve the Candidate learning curve and performance.

References:

Cellier, F. E., & Kofman, E. (2006) "Continuous System Simulation", Springer Science & Business Media, ISBN 978-0387261027

Law, A. M., Kelton, W. D., & Kelton, W. D. (1991) "Simulation Modeling and Analysis", McGraw-Hill, ISBN 978-0073401324

Banks, J. (1998) "Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice", John Wiley & Sons, ISBN 978-0471134039

Bruzzone A.G., Kerckhoffs (1996) "Simulation in Industry", SCS Europe Publishing

McLeod, J. (1982) “Computer Modeling and Simulation: Principles of Good Practice”, Society for Computer Simulation, San Diego, ISBN 978-9992501733

Montgomery D.C. (2000) "Design and Analysis of Experiments", John Wiley & Sons, New York

Spiegel M.R., Schiller L.J.(1999) " Statistics", McGraw Hill, NYC