Syllabus ISE 639

1) **Course name**
ISE 639 M&S Environments

2) **Course coordinator**
Dr. Mikel D. Petty, 256-824-4368, pettym@uah.edu

3) **Course description**
Architectures and attributes of modeling and simulation environments (live, virtual, constructive) and interoperability approaches (standalone, interoperable). Focus is on their application and suitability for testing and acquisition applications.

4) **Modules incorporated into course**
P4-G M&S environments and interoperability (General awareness)
P4-U M&S environments and interoperability (Understanding)
P4-A M&S environments and interoperability (Application)
P4-M M&S environments and interoperability (Mastery)

5) **ESRs that the course supports and the corresponding level of mastery**
ESR P4 General awareness, Understanding, Application, and Mastery

6) **Prerequisites assumed, and corresponding level of mastery**
Basic familiarity with M&S concepts, equivalent to MSIAC M&S Staff Officers Course

7) **Course maturity**
Not previously taught as a course; much of the material has been taught in other courses, particularly Old Dominion University's MSIM 601 course and in Certified Modeling and Simulation Professional examination preparation courses.

8) **Number of contact hours and pace contemplated**
Semester course: 3 lecture hours per week for 16 weeks

9) **Proposed delivery modality**
Face-to-face lecture, synchronous distance learning (live audio/video connection), asynchronous distance learning (web or CD)

10) **Proposed references and texts**
[1] R. M. Fujimoto, "Distributed Simulation and the High Level Architecture", in W. B. Rouse and K. R. Boff (Editors), *Organizational Simulation*, John Wiley & Sons, Hoboken NJ, 2005, pp. 591-609.
[2] R. M. Fujimoto, "Parallel and Distributed Simulation", in J. Banks (Editor), *Handbook of Simulation*, John Wiley & Sons, New York 1998, pp. 429-464.
[3] M. Petty, MSIM 601 and CMSP Exam Prep lecture notes.
[4] O. Balci, "Verification, Validation, and Testing", in J. Banks (Editor), *Handbook of Simulation*, John Wiley & Sons, New York 1998, pp. 335-393.

[5] J. A. Sokolowski and C. M. Banks, *Principles of Modeling and Simulation: A Multidisciplinary Approach*, Wiley, New York NY, 2008.

11) **Course learning objectives**

Correspond to sub-ESRs for ESR P4

a) P4.1 Define the different testing environments (live, virtual, and constructive) and compare the relative advantages and disadvantages of each environment for different product and system testing applications.
b) P4.2 Identify the attributes of an M&S application that determine whether a live, virtual, constructive, or a combination environment would be most appropriate, and the values for those attributes that indicate each type.
c) P4.3 List significant and widely used models, standalone simulations, confederated simulations, data sets, and interoperability protocol standards applied in the different environments.
d) P4.4 Describe approaches to testing and validating models and simulations suitable for use in each of the environments, and identify degree of accuracy typically required in that environment.
e) P4.5 Define the differences between standalone and federated simulation and give examples of each that have been used successfully in test and acquisition applications. Identify the attributes of an M&S application that determine whether a standalone simulation or a federation of interoperable simulations would be more appropriate, and the values for those attributes that indicate each type.
f) P4.6 List current simulation interoperability protocol standards and describe the advantages and disadvantages of each in each of the different environments.
g) P4.7 List existing resources in each of the environments, including model repositories, implemented federations of interoperable simulations, standalone simulations, standard object models, and accredited data sets, and describe the procedures for searching for resources within repositories of them.
h) P4.8 Describe case studies of successful test and acquisition M&S applications in each of the different environments.

12) **Course assessment plan**

1. Mid-term and final exams
2. Short-answer homework assignments, ~1 per week
3. Student special topic presentations, ~30 minutes, 2 per student per semester

13) **Topic list by hour of instruction and reference**

Listed for each hour are topic description, related sub-ESR, and reference (if any).

1. Basic concepts, definitions, and examples of live, virtual, and constructive environments; P4.1; [1] [2] [3]
2. Basic concepts, definitions, and examples of M&S application attributes; P4.2; [4]
3. Basic concepts, definitions, and examples of categories (models, standalone simulations, interoperable simulations, data sets, and interoperability protocol standards) within live, virtual, and constructive environments; P4.3; ; [1] [2] [3]
4. Basic concepts, definitions, and examples of testing and validation in live, virtual, and constructive environments; P4.4; [4]

5. Basic concepts, definitions, and examples of standalone and interoperable simulations; P4.5; ; [1] [2] [3]
6. Basic concepts, definitions, and examples of interoperability protocol standards; P4.6; [1] [2] [3]
7. Basic concepts, definitions, and examples of each type of existing resource in live, virtual, and constructive environments; P4.7; to be determined
8. Simple case studies of successful test and acquisition M&S applications; P4.8; to be determined
9. Typical product and system testing applications and advantages and disadvantages of live, virtual, and constructive environments for each; P4.1; [3]
10. Typical live, virtual, and constructive environment architectures; P4.1; [3]
11. Attributes of M&S applications typically found in live, virtual, and constructive environments; P4.2; [3]
12. Lists of significant and widely used items in each category and explanations for their significance live, virtual, and constructive environments; P4.3; to be determined
13. Details of different testing and validation methods used in live, virtual, and constructive environments; P4.4; [4]
14. Differences and advantages/disadvantages of standalone and interoperable simulations; P4.5; [1] [2] [3] [4]
15. Examples of successful use of standalone and interoperable simulations for test and acquisition applications; P4.5; to be determined
16. Technical details of current interoperability protocol standards; P4.6; [1] [2] [3]
17. Relative capabilities and typical applications of current interoperability protocol standards in live, virtual, and constructive environments; P4.6; [1] [2] [3]
18. Lists and details of existing resources in live, virtual, and constructive environments; P4.7; to be determined
19. Resource repositories in live, virtual, and constructive environments; P4.7; to be determined
20. Advanced case studies of both successful and unsuccessful test and acquisition M&S applications; P4.8; to be determined
21. Customizing live, virtual, and constructive environments for a specific application; P4.1; [1] [2] [3]
22. Determining the attributes of given M&S applications in live, virtual, and constructive environments; P4.2; to be determined
23. M&S application attributes in unusual applications and special cases; P4.2; to be determined
24. Recognizing significant, or potentially significant, items in live, virtual, and constructive environments; P4.3; to be determined
25. Performing testing and validation using existing methods in live, virtual, and constructive environments; P4.4; [4]
26. Applying standalone and interoperable simulations in test and acquisition M&S applications; P4.5; [1] [2] [3]
27. Attributes of M&S applications that determine whether a standalone or interoperable simulation would be more appropriate, and attribute values that indicate each type; P4.5; [1] [2] [3]

28. Applying interoperability protocol standards in test and acquisition M&S applications; P4.6; [1] [2] [3]
29. Procedures for examining, acquiring, customizing, and using existing resources; P4.7; to be determined
30. Adapting methods and lessons from a case study to a new test and acquisition M&S application; P4.8; to be determined
31. Analyzing a test and acquisition M&S application for lessons learned; P4.8; to be determined
32. Selecting among live, virtual, and constructive environments for a specific application based on environment characteristics; P4.1; [1] [2] [3]
33. Designing and integrating hybrid live, virtual, and constructive environments for specialized applications; P4.1; [1] [2] [3]
34. Selecting among live, virtual, and constructive environments based on M&S application attributes; P4.2; [1] [2] [3]
35. Selecting among available widely used items for an application within live, virtual, and constructive environments; P4.3; [1] [2] [3]
36. Selecting appropriate testing and validation methods in live, virtual, and constructive environments; P4.4; [4]
37. Developing new, enhanced, or hybrid environment-specific testing and validation methods in live, virtual, and constructive environments; P4.4; to be determined
38. Selecting among standalone and interoperable simulations based on the attributes of an M&S application; P4.5; [1] [2] [3]
39. Selecting among current interoperability protocol standards for a given M&S application in live, virtual, and constructive environments; P4.6; [1] [2] [3]
40. Selecting among existing resources for use in test and acquisition M&S application in live, virtual, and constructive environments; P4.7; to be determined
41. Selecting a case study relevant to a planned test and acquisition M&S application and extracting pertinent lessons learned; P4.8; to be determine