Syllabus for Basic Engineering Concepts in M&S II

Course name: Overview of Computers, Weapons Platforms, and Electrical Systems

1. **Course coordinator / point of contact and contact information**:
   Overall responsibility and coordination: Prof. Fotis A. Papoulias
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2. **Course description**: This course will provide introductory concepts of various engineering topics to the DoD Modeling and Simulation workforce member supporting Defense Acquisition so that they can obtain a general understanding of key M&S capabilities necessary for design, analysis, and maintenance of computers, weapons platforms, and Electrical engineering systems. The topics covered in the course include wave propagation, modeling and simulation approaches to complex system design and assessment, fundamentals of computer software and its limitations, basic concepts in electrical engineering and electrical machinery, and the fundamental issues involved in C4ISR systems. Upon completion, students should have basic understanding of the wide range of engineering concepts that are essential for physics-based engineering M&S.

3. **Modules incorporated into Course**: Eight modules as described in the topics.

4. **ESRs that the course supports and the corresponding level of mastery**.

Basic understanding for ESRs E-6 through E-10 as stated below:

- E6) Acoustic and Electromagnetic Systems - Describe the fundamentals of acoustic and electromagnetic wave propagation in M&S applications.
- E7) Military Platform Systems Engineering – Apply a broad-based design oriented M&S approach for complex platforms that interact with air-land-sea-based hardware systems, command and control systems and combat systems.
- E8) Computers - Describe the basic computer system architecture, operating systems, networking and introduction to engineering software and their applications. Classify structured programming languages such as Fortran and C, and the use of such tools for code development. Recognize finite element/difference codes, with application to solve engineering problems including experience with selected software packages.
- E9) Electrical Engineering - Describe basic circuit analysis including DC and AC circuits. Describe the construction and operating characteristics of rotating machinery, static converters, power distribution systems and multi-phased circuits.
- E10) C4ISR - Describe the basic components, methods and alternatives for transferring information from one point to another both internal and external to the system being considered. Evaluate available technologies for achieving rapid/effective/jam-resistant information transfer.

5. **Prerequisites assumed, and corresponding level of mastery**. Technical BS degree recommended. "Fundamentals of Engineering Structures" (may be taken concurrently) and "Introduction to Physics-Based M&S."

6. **Course maturity**: Not previously taught.

7. **Number of contact hours and pace contemplated**: 3 hours lecture/week for 16 weeks for a semester (or 4-hours lecture/week for 12 weeks for a quarter).

8. **Proposed Delivery modality**: Initially resident (face-to-face).

9. **Proposed references and texts**: Course notes will be provided.

10. **Course learning objectives**:
    a. Understand basic concepts of acoustical and electromagnetic wave propagation applied to physics-based engineering M&S.
    b. Understand basic concepts of electrical engineering and machinery applied to physics-based engineering M&S.
    c. Understand basic concepts of computer architectures and algorithms applied to physics-based engineering M&S.
    d. Understand basic concepts of communication theory, command, and control applied to physics-based engineering M&S.
    e. Understand basic concepts of sensors and weapon systems applied to physics-based engineering M&S.

11. **Course Assessment Plan**

1. Total of 3, 1-hr exams.
2. Homework assignments.
3. Term paper.

12. **Topic list by hour of instruction**.

Introduction	(1 hour)
Module 1: Wave Fundamentals	(6 hours)
1.1 Examples of Waves and Waves Modeling	(1 hour)
1.2 Reflection, Refraction and Interference	(1 hour)
1.3 Huygen's Principle and Diffraction	(1 hour)
1.4 Electromagnetic Waves	(1 hour)
1.5 Propagation of Electromagnetic Waves	(1 hour)
1.6 Acoustics and Underwater Acoustics	(1 hour)
Module 2: Fundamentals of Electrical Engineering	(9 hours)
2.1 Basic Laws	(1 hour)
2.2 Applications to Circuits	(1 hour)
2.3 Mechanical System Analogies	(1 hour)
2.4 Introduction to Electrical Machinery	(2 hours)
2.5 Power Generation	(2 hours)
2.6 Power Transmission and Distribution	(2 hours)

Module 3:	Introduction to Computers and Computing	(5 hours)
3.1	Operating Systems	(1 hour)
3.2	Programming Languages	(1 hour)
3.3	Finite Difference, Volume, and Element Methods	(1 hour)
3.4	Computer Program Pre-Processing	(1 hour)
3.5	Computer Program Post-Processing	(1 hour)
Module 4:	Introduction to Communications	(5 hours)
4.1	Signal Processing and Filtering	(1 hour)
4.2	Layered Communications and Computer Network	(1 hour)
4.3	Communication Systems	(1 hour)
4.4	Switching Technologies	(1 hour)
4.5	Defense Information System Network	(1 hour)
Module 5:	Introduction to Sensors	(6 hours)
5.1	Sensor Functions and Detection Theory	(1 hour)
5.2	Introduction to Radar	(1 hour)
5.3	Introduction to EO/IR (FLIR)	(1 hour)
5.4	Introduction to Sonar	(1 hour)
5.5	Using Sensor Data as External Navigation Aids	(2 hours)
Module 6:	Introduction to Weapon Systems	(9 hours)
6.1	Types of Weapons and Platforms	(1 hour)
6.2	Explosives and Warheads	(1 hour)
6.3	Bombs and Ballistic Missiles	(1 hour)
6.4	Guided Missiles	(1 hours)
6.5	Missile Propulsion and Aerodynamics	(2 hours)
6.6	Missile Guidance and Control	(2 hours)
6.7	Missile Design, Testing and Robustness	(1 hour)
Review and two exams		(3 hours)
	Total	(44 hours)