

## SYSTEMS ENGINEERING PROFESSIONAL COURSE

Systems Engineering Professional Course is jointly-developed and conducted by the National Defence University of Malaysia (NDUM) and Kongsberg Defence & Aerospace/University of Southeastern Norway (USN). The program will be conducted at NDUM campus in Kem Perdana Sungai Besi, Kuala Lumpur. Certificate of Attendance will be jointly issued by USN and NDUM.

The Systems Engineering Professional Course consists of three (3) modules as follows:

**a. Module 1: Fundamentals of Systems Engineering (13 – 17 March 2023)**

This is a MANDATORY induction module covering key concepts of Systems Engineering. The module allows the participants to actively explore a case running stepwise through the key concepts covered in the video and presentation materials. The module covers from eliciting stakeholders' requirements and needs in various domains to generate the technical requirements that determine the system's functionality and architecture including eventual the verification and validation of the final solution. The module is key for understanding the processes, methods and techniques for systems engineering and building awareness of how systems engineering approaches can enhance system performance throughout the life cycle.

**b. Module 2: Sustainability and Life Cycle (May / June 2023 – date to be determined)**

This module provides participants with a deep understanding of the importance to consider the full system lifecycle, looking into aspects of support and sustainment from early phases, such as in the supply chain management, all the way through the maintenance, upgrades and refits for life extension, to eventual phase-out. Robust engineering and system availability requirements are considered along with reliability block diagrams and architectures, preventive and correctional maintenance, and logistical lead times. The participants will consider the importance of logistics support elements and disciplines including spares, documentations, facilities, training, test equipment and others. In addition, the module introduces the participants to robust and reliability engineering, reliability growth programmes, integrated logistics and performance based logistics.

**c. Module 3: Systems Integration (Oct / Nov 2023 – date to be determined)**

Systems of Systems Integration is a critical and central part of the systems engineering. This third module I to address the key considerations for how to plan and perform integration activities as central part of the systems engineering. Overall, the module seeks to build a deeper insight into an integrator's holistic mind-set where elements, behaviours and properties of the system of interest gradually are combined into an operational and useful product or solution. This module will also address how to develop an integration plan adapting the development effort to the needs of the project and system of interest. Finally, to address how to define the architecture to support the integration and communication of the relevant architectural views such as the physical, functional, behavioural and non-functional along with capturing the interfaces and trade-offs.

# COURSE DESCRIPTIONS

## **Title: Module 1 - Fundamentals of Systems Engineering**

Date: 13 – 17 March 2023

Venue: UPNM

### **Target Participants:**

This module is targeted towards meeting the needs of working professionals, lecturers, and students with industry practice related to systems design and development. This is a mandatory pre-requisite module for Systems Engineering Professional Course conducted by UPNM and KDA/USN.

### **Pre-requisite:**

- Master's degree entry level, or
- Bachelor degree in engineering, computer science, or engineering management, or
- Prior experience or working knowledge Systems Engineering

### **Module Synopsis:**

Systems engineering is an interdisciplinary field of engineering and engineering management that focuses on approach to design and development of a holistic problem solution considering the entire system lifecycle from ideation through disposal. Systems engineering approach It begins with eliciting stakeholders' needs in various domains to generate requirements that determines the system's functionality and architecture including eventual verification and validation of the final solution. The module provides an overview and foundation for participants to achieve an understanding of and ability to apply a core subset of concepts, processes, methods, and techniques of systems engineering. The topics will be covered are;

- Introduction to systems engineering
- Systems thinking and Systems engineering
- Customers and business context
- Stakeholders' needs and requirements
- Architecting
- Design
- Verification and Validation
- Lifecycle Qualities
- System of systems integration
- Systems Engineering Management
- Cross topics

### **Learning Outcomes:**

At the end of this module the participant will be able to:

- Explain the fundamental processes, methods, and techniques for systems engineering

- Explain composition of a system, a system of systems, systems integration, system engineering management and system development lifecycle
- Understand how the systems engineering approach aids in improving the quality of a system's performance throughout the system's lifecycle.
- Identify and prioritize the stakeholders and elicit their needs and convert these needs into requirements that will influence the design and engineering of the system solution
- Apply the existing systems engineering methods or tailor a methodology with the intention to create a process for managing the progress and outcomes of a project
- Assess and integrate multiple perspectives in order to establish the holistic systems view
- Transfer and apply the knowledge, skills and attitude into daily practice and projects as systems engineers
- Appreciate the importance of systems thinking and apply systems thinking practises.

**Learning Activities and Module Deliveries:**

The module delivery combines the traditional lectures, discussions of papers, case studies, videos. Sharing of experience among the participants.

**Module Requirement and Assessments:**

- Oral presentation at the end of the module as compulsory assessment requirement
- Full attendance during the module delivery

## **Title: Module 2 - Sustainability and Lifecycle**

Date: May/June 2023

Venue: UPNM

### **Target Participants:**

This module is targeted towards meeting the needs of working professionals, lecturers, and students with industry practice related to systems design and development..

### **Pre-requisite:**

- Has attended the Fundamentals of Systems Engineering module.

### **Module Synopsis:**

Sustainability and lifecycle design in the context of systems engineering is a holistic approach to evaluate the impact associated with all stages of product's or solution's lifecycle from ideation throughout the phasing out stages. This module provides participants with a deep understanding of the importance to consider the full system lifecycle, looking into aspects of support and sustainment from early phases, such as in the supply chain management, all the way through the maintenance, upgrades and refits for life extension, to eventual phase-out. Robust engineering and system availability requirements are considered along with reliability block diagrams and architectures, preventive and correctional maintenance, and logistical lead times. The participants will consider the importance of logistics support elements and disciplines including spares, documentations, facilities, training, test equipment and others. In addition, the module introduces the participants to robust and reliability engineering, reliability growth programmes, integrated logistics and performance based logistics. The course addresses the following issues:

- Introduction to integrated logistics support. The transition of logistics to integrated logistics support, under the advent of the systems approach. Logistics support elements and related disciplines.
- Supply chain. Concept of supply chain. Elements in a supply chain. The Beer Game. The bullwhip effect.
- Reliability, maintainability, supportability. Fundamentals of reliability, maintainability and supportability. Concepts and metrics used. Activities per life-cycle phase.
- Effectiveness. Concept of effectiveness. Metrics used to assess system effectiveness. Guidelines for selecting the appropriate metrics based on system nature and utilization profile. Concept of degraded performance.
- Life-cycle cost. Concept of life-cycle cost. Cost breakdown structures. Cost estimating methods. Life-cycle cost versus life-cycle economic profile.
- Inventory management. Concept and types of inventory. Advantages and disadvantages of inventories.
- Transportation. Concept and types of transportation; advantages of each transportation means. Methods for planning transportations.
- Facilities. Concept and types of facilities. Criteria to be used in the selection of facilities.

- Documentation and configuration management. Technical documentation: concept and types. Preparation of technical manuals. Concept of configuration and of configuration management. Activities of configuration management. Concept and types of baselines.
- Spares management. Initial provisioning and re-provisioning of spares. Methods for the determination of spares. Criteria for refining the initial recommendation of spares. Problems associated with the use of mathematical models for spares quantification.
- Manpower, personnel, training and knowledge management. Determination of manpower, personnel and training requirements. Concept of data, information and knowledge; knowledge management. Knowledge maps. Use of knowledge maps for manpower, personnel and training-related purposes.
- Performance based logistics. Concept of performance-based logistics (PBL); reasons for evolving the outsourcing paradigm to contracting results and not resources. Main barriers to implementing a PBL contract. Selected examples of PBL contracts.

### **Learning Outcomes:**

After successfully completing this course, the participant:

- has a deep understanding of the role of logistics as facilitator and enabler of any industrial activity, as well as its essential role in achieving the systems engineering goal of developing effective and efficient systems in response to identified needs or perceived opportunities
- has a thorough view of the aspects of support and sustainment of systems from the early stages to the eventual phase out, and be able to use these aspects in their own systems designs
- is able to understand and analyse the logistic support elements and their inter-relationships and contributions to system supportability
- knows the logistics support elements and disciplines and understand their relative degree of importance in each case or project
- is able to understand and analyse the supply chains effect on systems supportability
- is able to address system reliability, maintainability, effectiveness and life-cycle cost
- understands the main features associated with each logistics support element and discipline, including spares, documentation, maintenance, test and support equipment, facilities and human resources
- has advanced knowledge within the field of supportability and logistics
- has thorough knowledge of the theories and methods in supportability and logistics
- can apply knowledge to new areas in the field of supportability and logistics
- can analyze and deal critically with various sources of information and use them to structure and formulate scholarly arguments

**Learning Activities and Module Deliveries:**

The module delivery combines the traditional lectures, discussions of papers, case studies, videos. Sharing of experience among the participants.

**Module Requirement and Assessments:**

- Oral presentation at the end of the module as compulsory assessment requirement
- Full attendance during the module delivery

## **Title: Module 3 - Systems Integration**

Date: October/November 2023

Venue: UPNM

### **Target Participants:**

This module is targeted towards meeting the needs of working professionals, lecturers, and students with industry practice related to systems design and development.

### **Pre-requisite:**

- Has attended the Fundamentals of Systems Engineering module.

### **Module Synopsis:**

Systems of Systems Integration is a critical and central part of the systems engineering. This third module I to address the key considerations for how to plan and perform integration activities as central part of the systems engineering. Overall, the module seeks to build a deeper insight into an integrator's holistic mind-set where elements, behaviours and properties of the system of interest gradually are combined into an operational and useful product or solution. This module will also address how to develop an integration plan adapting the development effort to the needs of the project and system of interest. Finally, to address how to define the architecture to support the integration and communication of the relevant architectural views such as the physical, functional, behavioural and non-functional along with capturing the interfaces and trade-offs. Topics will be covered include:

- Overview of System of Systems Integration
- Roles of Standards in Systems Integration
- Systems Integration Sequencing
- Systems Integration Strategy
- Systems Integration Plan

### **Learning Outcomes:**

After successfully completing this course, the participant:

- able to explain the lifecycle processes relevant to systems integration
- able to apply knowledge of methodology for verification, validation, qualification, transition, risk analysis and integration planning
- able to understand, tailor and implement the lifecycle processes relevant for systems integration
- able to understand, select, tailor and implement state-of-the-art and state-of-practice theory and methodology for systems integration
- able to use systems integration in project/product life cycle
- able to develop and implement a systems integration strategy
- able to develop and implement a systems integration plan

- aware, and adapt to the limits in knowledge, skills and competence in a organizations in relation to systems integration
- able to take calculated risks and uncertainties as a starting point to find potential problems early in integration.

**Learning Activities and Module Deliveries:**

The module delivery combines the traditional lectures, discussions of papers, case studies, videos. Sharing of experience among the participants.

**Module Requirement and Assessments:**

- Oral presentation at the end of the module as compulsory assessment requirement
- Full attendance during the module delivery



