

Country Poland	Institution Military University of Technology	Internship on Armament and Missile Technology	ECTS 10
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Service ALL	<p>Minimum Qualification for Lecturers</p> <ul style="list-style-type: none"> • Officers or civilian Lecturers: <ul style="list-style-type: none"> ○ English: Common European Framework of Reference for Languages (CEFR) Level B2 or min. NATO STANAG 6001 Level 3. ○ Thorough knowledge of particular technologies in armament and missile weapons. ○ Adequate knowledge of new trends in research and study on new technologies in armament.
Language English	

<p>Prerequisites for international participants:</p> <ul style="list-style-type: none"> • English: Common European Framework of Reference for Languages (CEFR) Level B1 or NATO STANAG Level 2. • At least 1 year of national (military) higher education. • Students with armament technology background. 	<p>Goal of the Module</p> <ul style="list-style-type: none"> • Deepen knowledge of armament and missile weapons in terms of weaponry systems, anti-aircraft systems and maintenance. • Discover and understand practical application of new technologies in armament and missile systems including control systems, manufacturing methods and maintenance. • Learn theoretical aspects of control and measurement systems, sensors and actuators, propulsion system of rockets, operation systems.
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Learning outcomes	Know- ledge	<ul style="list-style-type: none"> • Formulate fundamentals of the control and measurement systems analysis; • Define the basic operation of sensors and actuators; • Perform the mathematical description and simulation analysis; • Explain the fundamental procedures of armament maintenance; • Discuss the technologies applied in the area of weapon manufacturing and repairing; • Describe the rules of constructing and assembling of mechatronic devices; • Interpret the necessary terminology allowing him/her to express opinion, arguments, and feedbacks on armament and missile systems technology to be used within particular systems;
	Skills	<ul style="list-style-type: none"> • Demonstrate ability to design of computer models in MATLAB software with the use of some toolboxes; • Demonstrate ability to build simple model of printed circuit boards by using the Altium Designer software; • Demonstrate ability to elaborate laboratory models and some elements; • Demonstrate ability to do numerical calculations in areas of FEM analysis; • Demonstrate ability to program robots and to prepare codes for CNC machines; • Demonstrate ability to model simple structural elements in advanced CAD/CAE environment; • Demonstrate ability to apply techniques of Reverse Engineering in recreating structural element geometry.
	Respon- sibility and autono- my	<ul style="list-style-type: none"> • Perform practical work for application of particular technologies in armament; • Suitably use adequate tools for respective maintenance of the weapon; • Examine and correctly assess the trends in development of the new technologies in manufacturing and maintenance of weapon and missile systems and their potential future application.

Evaluation of learning outcomes

- **Observation:** Throughout the Module students will meet with the advanced weapon and missile systems applications and they will discuss the given topics in the seminars and present teamwork results. During these work students will be evaluated to verify their competences.
- **Interim tests:** Oral or written exams at the end of submodules.
- **Final Test:** Oral exam at the end of the module.

Module Details

Main Topic	Recom- mended WH	Details
Introduction to Finite Elements Analysis Application	24	<ul style="list-style-type: none"> • Introduction to finite element analysis; • Hydrocodes and description of materials behaviour; • Numerical simulations of mechanical problems; • Numerical simulations of thermal problems.
Fundamentals of design, manufacture and maintenance of the mechatronic system	30	<ul style="list-style-type: none"> • From a cloud of points to prototype. Element reconstruction based on measurement with a 3D scanner and reproduction of damaged part geometry. 3D scanner presentation, cloud of points acquisition, processing and modelling based on measured values; • Workshop of Computer Aided Design – some issues of surface modelling; • Computer Aided Design of selected part, modelling based on measured values. • Modification of the 3D model, FEA calculations and preparation of the prototype for printing by additive techniques (FDM, SLA).
The basics of Computer Aided Manufacturing	6	<ul style="list-style-type: none"> • Fundamentals of CNC machining, workshop of CAM (Computer Aided Manufacturing) software;
The basics of NDT	6	<ul style="list-style-type: none"> • Introduction to Non-Destructive Tests, optical methods for assessing the technical condition of the barrel.
Fundamentals of armament of the Land Forces	18	<ul style="list-style-type: none"> • Demonstrational exercises of small arms; • Demonstration of artillery and armament of combat vehicles; • Demonstrational exercises of ammunition; • Demonstrational exercises at the Weapon Systems Laboratory.
Visualization and simulation in rocket technology	30	<ul style="list-style-type: none"> • Modelling and simulation of missile flight; • Virtual reality in rocket technology; • Tracking manoeuvring objects using robust multi-model state estimation and information fusion techniques; • Design and analysis of electrical circuits, • Object-oriented programming in MATLAB for the purpose of implementation and verification of the elaborated models.
Selected issues of signal processing	24	<ul style="list-style-type: none"> • Design and analysis of electrical circuits using the Altium Designer software; • Design and analysis of FIR and IIR filters using the MATLAB software; • Generation and processing of echolocation signals - hardware solutions; • Generation and processing of echolocation signals - software solutions.
Selected issues of command and telecommunication systems	12	<ul style="list-style-type: none"> • Selected tactical data links (TDL), data exchange protocols used in air defence systems - Asterix, Link 11, Link 16 (JREAP), AdatP-3; • Network-centric systems - ISO / OSI, TCP / IP models, introduction to IP networks, IP network management principles.
Selected issues of missile technologies	12	<ul style="list-style-type: none"> • Technical support for missile fire units. Guided missile transporters; • Anti-aircraft missile reloading procedures. Health and safety rules during reloading missiles.
Robotics and industrial automation	24	<ul style="list-style-type: none"> • Off-line programming of industrial robots; • On-line-line programming of industrial robots; • Construction and control principles of electropneumatic systems; • Modelling and simulation of the functioning of electropneumatic systems.

Introduction to External Ballistics	18	<ul style="list-style-type: none"> Basics of external ballistics, basic definitions, forces and moments acting on projectiles during flight, Point mass trajectory, modified point mass trajectory, 6-DOF trajectory, Numerical simulation of projectile behaviour during flight using Ansys Fluent and Prodas software.
Fundamentals of flight simulators	6	<ul style="list-style-type: none"> Demonstrational exercises at the Simulators Workshop, Laboratory of Avionics.
Fundamentals of aerospace constructions technologies	6	<ul style="list-style-type: none"> Demonstrational exercises on the civilian and military aircraft.
Fundamentals of aerodynamics and thermodynamics	6	<ul style="list-style-type: none"> Demonstrational exercises at the Laboratory of Aerodynamics and Thermodynamics.
Fundamentals of air armament systems	6	<ul style="list-style-type: none"> Demonstrational exercises at the Laboratory of Air Armament.
Metallographic research laboratory	6	<ul style="list-style-type: none"> Microscope research demonstration.
Familiarization with the student scientific organization	6	<ul style="list-style-type: none"> Selected topics of student projects within Student Scientific Society.
Total	240	
Additional hours (WH) to increase the learning outcomes		
Self-Studies	60	<ul style="list-style-type: none"> Separate hours for in-depth-studies on an as-required basis; Those hours comprise work of students in laboratories and exercises to improve skills and consolidate knowledge.
Total WH	300	<p>Remarks:</p> <ul style="list-style-type: none"> The module encourages the active participation of students; The detailed amount of hours for the respective main topic is up to the course director according to national law or home institution's rules.



List of Abbreviations:

- B1, B2 Common Reference Levels
- CEFR Common European Framework of Reference for Languages
- Col Colonel
- Doc. Document
- e. g. exempli gratia (for example)
- ECTS European Credit Transfer and Accumulation System
- ESDC European Security and Defence College
- IG Implementation Group
- LtCol Lieutenant Colonel
- NATO North Atlantic Treaty Organization
- PhD Doctor / Doctor of Philosophy
- PL Poland
- STANAG Standardization Agreement
- WH Working Hour / Working Hours