

EDUCATIONAL SKILL REQUIREMENTS (ESR)
 2025-27 EDUCATIONAL SKILL REQUIREMENTS
Electrical/Electronic Systems Engineering (590)
Subspecialty 5300 Series
Master of Science in Electrical Engineering
Electrical Engineer's Degree
Doctor of Philosophy in Electrical Engineering

1. Curriculum Number: 590
2. Curriculum Taught at NPS: Electrical/Electronic Systems Engineering
3. Curriculum Length in Months: 12–30
4. APC Required: 323
5. The officer must understand the fundamental concepts and be familiar with the basic functional areas of Electrical/Electronic Systems Engineering within the Department of the Navy (DON) and the DoD, including:

a. ESR-1: The MSEE degree program requires undergraduate equivalency for students without an electrical engineering undergraduate degree. Mathematics for the MSEE and Electrical Engineer’s Degree (all non-CWES tracks): The officer will have a thorough knowledge of mathematical tools, which are intrinsic to electrical and computer systems engineering, including but not limited to differential equations, vector analysis, linear algebra, probability, and Fourier and Laplace methods.

Curriculum Number:	590/592	
Subspecialty Code:	5300–5313P/N	
Degree Awarded:	MSEE, Electrical Engineer’s Degree	
Note: Requirements may also be met through undergraduate equivalency		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
MA1113	Single Variable Calculus (4-0)	
MA1114	Single Variable Calc II w/ Matrix Algebra (4-0)	
MA1115	Multi-variable Calculus (4-0)	
MA1116	Vector Calculus (3-0)	
MA2121	Differential Equations (4-0)	
MA2043	Introduction to Matrix and Linear Algebra (4-0)	
EC2010	Probabilistic Analysis of Signals & Systems (4-1)	

b. ESR-2: Engineering Science and Design for MSEE and Electrical Engineer’s Degree: To acquire the requisite background needed to meet the other military education requirements, the officer will acquire proficiency in modern physics, electromagnetics, electronic devices and circuits, system theory, modern electronic system design, and integrated electrical power systems and their controls. In addition, proficiency will be gained in other appropriate fields, such as underwater acoustics, dynamics, fluid mechanics, thermodynamics, or energy science and technology, that provide the requisite breadth to a military engineering education.

Enclosure (2)

Curriculum Number:	590/592	
Subspecialty Code:	5300–5313P/N	
Degree Awarded:	MSEE, Electrical Engineer’s Degree	
Note: Requirements may also be met through undergraduate equivalency and/or MSEE courses		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
PH1121	Mechanics (4-2)	
PH1322	Electromagnetism (4-2)	
EC2010	Prob Analysis of Signals and Systems (3-1)	
EC2100	Circuit Analysis (3-2)	
EC2110	Circuit Analysis II (3-2)	
EC2220	Electrical Engineering Design (3-4)	
EC2440	Intro to Scientific Programming (3-2)	AE2440
EC2320	Linear Systems (3-1)	
EC2400	Discrete Systems (3-1)	
EC2410	Analysis of Signals and Systems (3-1)	
EC2500	Communications Systems (4-0)	
EC2650	Fundamentals of Electromagnetic Fields (4-1)	
EC2820	Digital Logic Circuits (3-2)	EC2840

ESR-3: Electronic and Electrical Engineering for MSEE and Electrical Engineer’s Degree Specialization. Each student will also acquire technical competence in two or more of the following tracks through additional graduate-level courses and their associated prerequisites:

1. Communication Systems*
2. Guidance, Control & Navigation Systems*
3. Power or Energy Systems
4. Signal Processing Systems
5. Electronics*
6. Cyber Systems
7. Computer Systems*
8. Sensor Systems Engineering
9. Network Engineering*

A single sub-specialty code (P or N code) will be awarded based on the completion of a track that best supports the area of independent investigation outlined in ESR-4.

For Track 1*, Communication Systems, the following courses are required. These are to include material covering radio communications, modulation, forward error correction coding, electronic countermeasures, software-defined radio, and other military issues.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3500	Analysis of Random Signals (4-0)	
EC3510	Communications Engineering (3-1)	
EC4550	Digital Communications (4-0)	
EC4580	Coding and Information Theory (4-0)	

For Track 2*, Guidance, Control, and Navigation Systems, the following courses are required. These are to include material covering robotics, unmanned systems, target tracking, sensors as applied to guidance and control, and data association.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3310	Optimal Estimation: Sensor & Data Association (3-2)	
EC3320	Optimal Control Systems (3-2)	
EC4310	Fundamentals of Robotics (3-2)	
EC4350	Nonlinear Control Systems (3-2)	

For Track 3, Power or Energy Systems, the following courses are required. These are to include material covering shipboard electric machinery, converters for advanced shipboard power, simulation and analysis of power electronic drives, alternative energy generation and utilization, and energy conservation and storage.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3130	Electrical Machinery Theory (3-3)	
EC3150	Power Electronics (3-2)	
EC4130	Advanced Electrical Machinery Systems (3-3)	
EC4150	Applied Power Electronics (3-2)	

For Track 4, Signal Processing Systems, the following courses are required. These are to include material covering signal analytics for efficient extraction, representation, and identification of information as applied to surveillance, signals intelligence, RF, underwater data acquisition, processing, imaging, and other defense-related issues.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3400	Digital Signal Processing (3-2)	
EC3410	Discrete-Time Random Signals (3-2)	
EC4440	Statistical Digital Signal Processing (3-2)	
EC4450	Array Signal Processing Engineering (3-2)	

For Track 5*, Electronics, the following courses are required. These are to include material covering

semiconductor nanotechnology for defense-related electronic technologies reliability, and radiation hardening for electronic military systems, solar cell photovoltaic components engineering techniques for analog IC design, and modeling & simulation.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3200	Advanced Electronics Engineering (3-2)	
EC3220	Semiconductor Device Technology (3-2)	
EC4220	Introduction to Analog VSI (3-1)	
EC4230	Reliability Issues for Military Electronics (3-1)	

For Track 6, Cyber Systems, the following courses are required. These are to include material covering a rigorous treatment of the cyber infrastructure, reverse engineering of cyber systems, cyber systems vulnerabilities and risk assessment, cyber warfare systems, telecommunications systems engineering, and Internet engineering.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3730	Cyber Network & Physical Infrastructures (3-2)	
EC3740	Reverse Engineering in Electronic Systems (3-2)	
Classified: (US only, with appropriate security clearance)		
EC3760	Information Operations Systems (3-2)	
EC4765	Cyber Warfare (3-2)	
Unclassified		
EC4730	Covert Communications (3-2)	
EC4770	Wireless Communications Network Security (3-2)	

For Track 7*, Computer Systems, the following courses are required. These are to include material covering logic design, FPGA and ASIC design, computer architecture and the hardware/software interface, parallel and distributed computing, embedded and real-time computing, computer systems modeling, simulation, and analysis.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3800	Microprocessor-based System Design (3-2)	
EC3840	Introduction to Computer Architecture (3-2)	
EC4820	Advanced Computer Architecture (3-2)	
EC4830	Digital Computer Design (3-2)	

For Track 8, Sensor Systems Engineering, the following courses are required. These are to include material covering sensor signal processing, radar systems, RF and microwave devices, antennas and propagation, network-enabled electronic warfare, and spectrum management.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3600	Antennas & Propagation (3-2)	
EC3615	Radar Fundamentals (3-2)	
EC4615	Advanced Radar (3-2)	EC4630
EC4685	Principles of Electronic Warfare (3-2)	

For Track 9*, Network Engineering, the following courses are required. These are to include material covering wireless networks, sensor networks, high-speed data networking, the Internet, and telecommunication systems.

Required Course #	Description (Credits: Lecture-Lab)	Alternate Course
EC3710	Computer Communications Methods (3-2)	
EC4725	Advanced Telecommunication Systems Engineering (3-2)	
EC4745	Mobile Ad Hoc Wireless Networking (3-2)	
EC4785	Internet Engineering (3-2)	

* Academic offerings at NPS have been temporarily suspended

d. ESR-4: Conducting and Reporting Independent Investigation: The officer will demonstrate the ability to conduct an independent investigation of a Navy and/or DOD-relevant electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

Curriculum Number:	590/592	
Subspecialty Code:	All - 53XXP/N	
Degree Awarded:	MSEE, Electrical Engineers Degree, MSES(EE)	
Note: Requirements met via completion of a Defense-relevant research project, written thesis, and oral presentation		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
EC3000	Introduction to Graduate Research (1-0)	
EC0810	Thesis Research (0-8) [5-6 EC0810 course enrollments per student program of study]	

e. ESR-5: Engineering Duty Officer Cyber Education for MSEE and Electrical Engineers Degree. The officer will have a sound understanding of cyber infrastructure systems and technologies of interest to the military. Knowledge will include, but not be limited to, the underlying principles of cyber infrastructure and systems, inherent vulnerabilities and threats, and defensive security procedures. Specific focus areas should include computer systems, computer networks - including Ethernet, Internet Protocol, address resolution, and routing protocols, wired and wireless communication systems, cyber security and Defense, and industrial control systems.

Curriculum Number:	590	
Subspecialty Code:	5300-5313P/N – EDO Only	
Degree Awarded:	MSEE, Electrical Engineer's Degree	
Note: Requirement for Engineering Duty Officers to receive cyber education. Requirements can be satisfied through ECE cyber courses, including the sequence EC2700 & EC3730.		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
EC2700	Intro to Cyber Systems (3-3)	EC3730

f. ESR-6: Cyber Warfare Engineering and Science (CWES) track subspecialty requirements for the MSES(EE) degree. This ESR pertains only to Navy CWE/1840 officers enrolled in the 590 curriculum.

(1) CWE Computer Network Communications: The officer will have thorough knowledge and proficiency in the theory, design, and operation of wired and wireless computer communications and networks, as well as communications security practices.

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Note: Requirements may also be met through undergraduate or graduate equivalency		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
SS3610	Space Communications Systems Fundamentals & Analysis (4-2)	EC2500, EO3502
EC3710	Computer Communications Methods (3-2)	CS3502
EC4730	Covert Communications (3-2)	
EC4745	Wireless Ad-Hoc Networks (3-2)	EC3795
EC4770	Wireless Network Security (3-2)	
CS4558	Network Traffic Analysis (3-2)	

(2) CWE Cyber Systems Engineering and Security: The officer will have knowledge and proficiency in the design and implementation of computers and hardware security, including the reverse engineering of cyber systems.

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Note: Requirements may also be met through undergraduate or graduate equivalency		
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
EC3730	Cyber Networks & Physical Infrastructure (3-2)	
EC3740	Reverse Engineering Electronic Systems (3-2)	
CS3600	Intro to Computer Security (4-2)	

Enclosure (2)

CS4677	Computer Forensics (3-2)	
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(3) Cyber Warfare Engineering & Science: In order to provide officers skilled in the application of electronic systems to cyber warfare needs, the officer will have additional competence in specialized topics supporting the broad area of cybersecurity. To achieve depth and breadth of understanding, the officer shall take at least six of the following courses to specialize in a minimum of two specialties from the following list: artificial intelligence (AI)/machine learning (ML)/data science, cryptography, embedded systems, cyber adversarial techniques, cyber system acquisition and modeling, cyber policy and analysis, applied cyber operations, random signals analysis, and electronic warfare.

a) AI/ML/Data Science – including computational methods and statistical foundations for AI and ML, algorithms, and military applications

Curriculum Number:		590
Subspecialty Code:		5314P (proposed)
Degree Awarded:		MSES(EE)
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
OA3802	Computational Methods for Data Analysis (4-0)	
CS3315	Introduction to ML and Big Data (3-1)	CS3310
AE4824	Deep Learning for Military Systems (3-2)	CS4321
OA4118	Statistical and Machine Learning (4-0)	OA4106, CS4324

b) Cryptography - including mathematical foundations of cryptography and design and attack of cryptographic algorithms

Curriculum Number:		590
Subspecialty Code:		5314P (proposed)
Degree Awarded:		MSES(EE)
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
MA4570	Cryptography (4-1)	
CS4615	Cryptographic Protocol Design and Attacks (3-1)	

c) Cyber Adversarial Techniques - including advanced computer and network security, vulnerability assessment, friendly and adversarial cybersecurity operations, and malware analysis and design

Curriculum Number:		590
Subspecialty Code:		5314P (proposed)
Degree Awarded:		MSES(EE)
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
CS3690	Network Security (4-1)	

CS4648	Advanced Cyber Munitions (3-2)	
CS4678	Advanced Cyber Vulnerability Assessment (4-2)	CS4324
CS4679	Advances in Cyber Security Operations (4-1)	

d) Embedded Systems Engineering – principles of embedded system elements of military systems, including digital logic, embedded systems, and real-time programming, modeling & simulation with hardware description languages, CPU operations and interaction with software and hardware, embedded systems design, and hardware optimization for specialized computing.

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
EC2820	Digital Logic Circuits (3-2)	
EC3800	Microprocessor-Based System Design (3-2)	EC3840
EC4830	Digital Computer Design (3-2)	EC4820

e) Cyber Systems Acquisition and Modeling - including principles of acquisition and program management, capabilities engineering and analysis, modeling and simulation for acquisition, and software cybersecurity and acquisition.

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
SE3250	Capabilities Engineering (3-2)	SE3100
SE4420	Modeling and Simulation for DoD Acquisition (2-0)	
MN3331	Principles of Acquisition and Program Management (5-1)	
MN3309	Software Acquisition Management and Cybersecurity (4-1)	

f) Electronic Warfare - including fundamentals of the electromagnetic spectrum, antennas and propagation, and AI and ML methods supporting signal analysis and electromagnetic spectrum operations

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #

EC3460	Intro to ML for Signal Analytics (3-2)	
EC3600	Antennas and Propagation (3-2)	
EC3615	Radar Fundamentals (3-2)	PH3052, EC3760

g) Applied Cyber Operations - including advanced network security, applied defensive cyber operations, and adversarial cyber operations

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
CS3690	Network Security (4-1)	
CY4700	Applied Defensive Cyber Operations (3-3)	
CY4710	Adversarial Cyber Operations (3-3)	

h) Cyber Policy and Analysis - including cyber policy design and analysis, information operations using the electromagnetic spectrum, and conflict analysis relative to cyber warfare

Curriculum Number:	590	
Subspecialty Code:	5314P (proposed)	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
DA3105	Conflict and Cyberspace (4-1)	
DA3180	Warfare in the Electromagnetic Spectrum (4-0)	
CY4410	Cyber Policy and Strategy (3-0)	

i) Exploitation of Cyber Systems and Intelligence Collection - including information operations systems and collection systems design and engineering

Curriculum Number:	590	
Subspecialty Code:	TBD	
Degree Awarded:	MSES(EE)	
Required Course #	Description (Credits: Lecture-Lab)	Alternative Course #
EC3760	Information Operations Systems (3-2)	
EC4765	Cyber Warfare (3-2)	

6. Major Area Sponsor and Subject Matter Experts

- a. Major Area Sponsor: VADM James. P. Downey, Commander, NAVSEA
- b. Curriculum Sponsor: RADM Kurt J. Rothenhaus, Commander, NAVWAR
- c. Designated SME: CDR Scott Lord PMW-120, scott.f.lord.mil@us.navy.mil, (619) 925-6596.

APPROVED:	LORD.SCOTT.FRED ERICK.	Digitally signed by LORD.SCOTT.FREDERICK. Date: 2026.01.20 13:28:03 -08'00'	20 Jan 2026
	Subject Matter Expert		Date
APPROVED:	MICHAEL.JAME S.B.	Digitally signed by MICHAEL.JAMES.B. Date: 2026.01.20 17:56:50 -08'00'	20 Jan 2026
	Vice Provost of Academic Affairs, NPS		Date
APPROVED:	GRIGG.FAITH.KR STEN.	Digitally signed by GRIGG.FAITH.KRISTEN. Date: 2026.02.18 14:25:11 -05'00'	18 Feb 2026
	Director, OPNAV N71		Date