



**Jordan University of Science and Technology**  
**Faculty of Computer and Information Technology**  
**Department of Network Engineering and Security**

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**Study Plan of Bachelor Degree in Network Engineering and Security**

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**(2015 – 2016)**

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**Vision:**

To be a distinguished program in network engineering and security in Jordan and the region that is recognized for high-quality education and research.

**Mission:**

1. Prepare practitioner-oriented network engineering and security professionals and future leaders.
2. Provide flexible and dynamic curriculum that is responsive to the needs of the dominant and growing computer networking industries in the region.
3. Deliver high-quality state-of-the-art research both theoretical and applied.
4. Strengthen partnerships that facilitates the collaboration of computer networking industry, government, and education.
5. Support technological development and innovation that meet the needs of the local community.

**Objectives:**

The graduates of the Department of Network Engineering and Security will be:

1. Productive and practitioner-oriented professionals and future leaders.
2. Problem solvers who apply technological solutions to business needs.
3. Researchers that contribute to the development and innovation of the computer networking fields.
4. Citizens that support economic and social development of the local community.
5. Lifelong learners who can always improve the professional knowledge.

**Outcomes:**

The graduates of the program of Network Engineering and Security will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Study Plan of Bachelor degree in Network Engineering and Security (2015 – 2016)

### Numbering and coding system of courses of the study plan.

#### Course Coding

The following codes are used to designate courses:

Department			Level/year	Field	Sequence
A	B	C	x	y	z

The Department codes (A, B, C) are as follows:

Code	Department
NES	Network Engineering and Security
CPE	Computer Engineering
CS	Computer Science
CIS	Computer Information Systems
SE	Software Engineering

#### Course Numbering

- The Network Engineering and Security courses are tabled and numbered in such a manner to recognize each course regarding its subject area, year or level, and semester offered.  
Ex. **NES** xyz: The **NES** symbol in the course number denotes **Network Engineering and Security** and (xyz) is a 3-digits number:

A. The first digit denotes the year level of the course according to student's study plan as follows:

Code	Level/year
1	First
2	Second
3	Third
4	Fourth
5	Fifth

B. The second digit denotes the course field subject as follows:

Number	Specialization
0	Supporting
1	General
2	-
3	-
4	Wireless
5	Security
6	Multimedia
7	Network management
8	Others
9	Graduation projects, training, and special topics

C. The third digit denotes sequence of semester during which the course is offered according to the study plan. In way that odd numbers are given to the first and summer semesters while even numbers are given to second semesters.

**Example:** NES 452 Cryptography and Network Security means:

NES	4	5	2
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Network Engineering and Security	Level (Fourth year)	Field (Security)	Sequence (Second semester)
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A Bachelor of Science (B.Sc.) degree in Network Engineering and Security at JUST is awarded in accordance with the statute stated by JUST regulations for B.Sc. awarding issued by the Dean's Council based on the adjusted 1987 law for awarding scientific degrees and certifications at JUST after completing (160) credit hours successfully.

The study plan composed of the following:

**Table 1: Credit Hours Distribution for Network Engineering and Security Major**

Classification	Credit hours		
	Compulsory	Elective	Total
University requirement	16	9	25
Faculty requirement	27	0	27
Department requirement	96	12	108
Total	139	21	160

### **1.University Requirements (25 CHs):**

#### **1-a) University Mandatory Courses (16 CHs) as shown in Table 2:**

**Table 2: University Mandatory Courses**

Course Number	Course Title	Credit Hours	Lecture	Practical	Prerequisite
MS 100 <sup>(1)</sup>	Military Science	3	3	0	-
ARB 101	Arabic Language	3	3	0	-
HSS 110	Social Responsibility	3	2	1	-
ENG 112	English Language II	3	3	0	Eng 99 or Passing the English Skills Exam with a grade of 50% or more
HSS 119	Entrepreneurship and innovation	2	2	0	-

<sup>1-</sup> The grade for this course is a Pass/Fail grade. Non-Jordanian students can take a substitute course from the elective courses, and the grade for the elective course goes into the calculation of the grade point average.

HSS 129	General Skills	2	2	0	ENG 112
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**NOTE:** Non-Arabic speaking students register for the following course instead of (ARB 101):

Course Number	Course Title	Credit Hours	Lecture	Lab
ARB 101A	Fundamentals of Arabic language for Non-Arabs	3	3	0
HSS 110 A	Social Responsibility (in English)	3	3	0

**1-b) University Elective Courses (9 CHs):**

The student selects one course from each of the three groups in Table (3)

**Table 3: University Elective Courses**

Course No.	Course title	Credit hours	Theoretical	Lab
<b>Group 1: Humanities Field</b>				
ARB 200	Appreciation of literary texts	3	3	0
HSS 115	Islam and recent problems	3	3	0
HSS 116	Economic system in Islam	3	3	0
HSS 121	Principles of sociology	3	3	0
HSS 126	Principles of psychology	3	3	0
HSS 127	Educational technology	3	3	0
HSS 131	Islamic civilization	3	3	0



HSS 132	The history of the city of Jerusalem	3	3	0
HSS 133	Civilization and recent cultures	3	3	0
HSS 135	Islamic culture	3	3	0
HSS 137	Human rights	3	3	0
HSS 141	Introduction to economics (for non CIS students)	3	3	0
HSS 142	Library and information research	3	3	0
HSS 161	Contemporary problems	3	3	0
HSS 211	Sociology (in English)	3	3	0
HSS 213	Individual and society	3	3	0
HSS 221	Introduction to psychology (in English)	3	3	0
HSS 231	History of science in Islam	3	3	0
<b>Group 2: Science and Agriculture Field</b>				
ES 103	Environnement protection (for non environnement sciences students)	3	3	0
ME 102	Introduction to renewable energy	3	3	0
ME 211	Fundamentals of automobile engineering (for non-ME students)	3	3	0
CHE 191	Introduction to the nanotechnology	3	3	0
NF 177	Food preservation (in English)	3	3	0
AP 200	Farm animal products and production (for non agriculture and veterinary students)	3	3	0
PP 200	Home gardens (for non-agriculture students)	3	3	0
PP 201	Bee keeping (for non-agriculture students)	3	3	0

PP 202	Natural plants of Jordan (for non agriculture students)	3	3	0
<b>Group 3: Medical Field</b>				
NUR100	Health promotion	3	3	0
ADS 100	Oral and dental health (for non-dentistry and non dentistry sciences students)	3	3	0
PH 104	Community health and nutrition (for non-medicine, non-nursing, and non-midwifery students)	3	3	0
VM 211	Animal health (not for veterinary medical and agriculture students)	3	3	0
VM 212	Pet animal care	3	3	0
PT 100	Wellness and life styles (for non-physical therapy students)	3	3	0

## 2. Faculty Requirements (27 CHs):

**Table 4: Mandatory Faculty Requirements**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
MATH 101	Calculus I	3	3	0	-
MATH 102	Calculus II	3	3	0	MATH 101
MATH 241	Discrete Mathematics	3	3	0	-
CS 101	Introduction to Programming	3	3	0	CIS 99 or Passing the Computer Skills Exam with a grade of 50% or more
CS 102	Programming Lab	1	0	3	CS 101 or Concurrent
CS 112	Introduction to Object-Oriented Programming	3	3	0	Passing CS 102
CS 113	Object-Oriented Programming Lab	1	0	3	CS112 or Concurrent
CS 211	Data Structures	3	3	0	MATH 241+ passing CS 112
CIS 200	Professional & Ethical Issues in Computing	1	1	0	-
CIS 201	Introduction to Web Design	1	0	3	CS 113

CIS 202	Communication Skills	2	2	0	CIS 200 or Concurrent
CIS 221	Fundamentals of Database Systems	3	3	0	CS 211

### 3. Department Requirements (108 CHs):

#### 3-a) Department Mandatory Courses from other Departments (51 CHs):

##### 3-a1) Mandatory Courses from the Department of Computer Engineering (17 CHs):

**Table 5: Mandatory Courses from the Department of Computer Engineering**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
CPE 231	Digital Logic Design	3	3	0	CS113
CPE 232	Digital Logic Design Lab	1	0	3	CPE 231
CPE 252	Computer Organization and Design	3	3	0	CPE 231
CPE 351	Microprocessor Systems	3	3	0	CPE 252
CPE 352	Computer Architecture	3	3	0	CPE 252
CPE 354	Microprocessor Systems Lab	1	0	3	CPE 232 + CPE 351
CPE 473	Operating Systems	3	3	0	CPE 352

##### 3-a2) Mandatory Courses from the Department of Electrical Engineering (14 CHs):

**Table 6: Mandatory Courses from the Department of Electrical Engineering**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
EE 212	Electrical Circuits Analysis	3	3	0	PHY 102 + MATH 203 or Concurrent
EE 213	Electrical Circuits Lab	1	0	3	EE 212
EE 204	Introduction to Linear Systems	3	3	0	MATH 203
EE 260	Signals and Systems Analysis	3	3	0	EE 212 + EE 204 or Concurrent
EE 321	Fundamentals of Electronics ( <i>for Non-EE Students</i> )	3	3	0	EE 212

EE 322	Electronic Circuits Lab	1	0	3	EE 213 + EE 321
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**3-a3) Mandatory Courses from the Department of Mechanical Engineering (4 CHs):**

**Table 7: Mandatory Courses from the Department of Mechanical Engineering**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
ME 200	Engineering Drawings "A"	1	0	3	CIS 99 or Passing the Computer Skills Exam with a grade of 50% or more
ME 215	Engineering Mechanics	3	3	0	PHY 101

**3-a4) Mandatory Courses from the Department of Mathematics (6 CHs):**

**Table 8: Mandatory Courses from the Department of Mathematics**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
MATH 201	Intermediate Analysis	3	3	0	MATH 102
MATH 203	Ordinary Differential Equations	3	3	0	MATH 102

**3-a5) Mandatory Courses from the Department of Applied Physics (7 CHs):**

**Table 9: Mandatory Courses from the Department of Applied Physics**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
PHY 101	General Physics I	3	3	0	-
PHY 102	General Physics II	3	3	0	PHY 101
PHY 107	General Physics (LAB)	1	0	3	PHY 102

**3-a6) Mandatory Courses from the Department of Chemistry (3 CHs):**

**Table 10: Mandatory Courses from the Department of Chemistry**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
CHEM 103	General Chemistry	3	3	0	-

**3-b) Department Mandatory Courses from the Department of Network Engineering and Security (45 CHs):**

**Table 6: Department Mandatory Courses from the Department of Network Engineering and Security**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
NES 202	Introduction to UNIX	3	3	0	CS 211
NES 301	Probability and Queuing Theory	3	3	0	MATH 241
NES 311	Data Communication	3	3	0	CPE 231 + EE 260 or Concurrent
NES 312	Fundamentals of Computer Networks	3	3	0	NES 311 + NES 301
NES 413	Computer Networks Laboratory	1	0	3	NES 312
NES 415	Networking Protocols	3	3	0	NES 312
NES 416	Network Programming	3	3	0	NES 202 + NES 312 + CPE 473
NES 441	Wireless Networks	3	3	0	NES 312
NES 442	Wireless Networks Laboratory	1	0	3	NES 441 + NES 413
NES 451	Basics of Information System Security	3	3	0	NES 301 + NES 311
NES 452	Cryptography and Network Security	3	3	0	NES 312 + NES 451
NES 460	Multimedia Networking	3	3	0	NES 415
NES 470	Network Management	3	3	0	NES 415
NES 490	Practical Training	3	0	0	Completion of 120 CHs
NES 553	Network Security Laboratory	1	0	3	NES 452
NES 554	Computer Network Defense	3	3	0	NES 452
NES 591	Graduation Project "1"	1	0	0	Completion of 120 CHs
NES 592	Graduation Project "2"	2	0	0	NES 591

**3-c) Department Elective Courses (12 CHs): (\*)**

- Student must select at least (6 CHs) from the Department of Network Engineering and Security.
- Student may select at most (6 CHs) from other CIT departments.

**Table 7: Department Elective Courses**

Course Number	Course Title	Credit Hours	Lecture	Lab	Prerequisite
NES 510	Network Simulation and Modeling	3	2	1	NES 416
NES 540	Wireless Networking Protocols	3	3	0	NES 441
NES 541	Wireless Networks Security	3	3	0	NES 441 + NES 452
NES 580	High-Speed Networks	3	3	0	NES 415
CPE 551	Advanced Computer Architecture	3	3	0	CPE 352
CPE 560	Distributed Systems and Middleware	3	3	0	CPE 473
CS 411	Mobile Applications Design and Development	3	3	0	CS 211
CS 476	High Performance Computing	3	3	0	CPE 352
CIS 421	Database applications	3	3	0	CIS 221
CIS 451	E-business	3	3	0	CIS 201
CIS 482	Operations research	3	3	0	CS 112 + NES 301
SE 431	Software Security	3	3	0	SE 230
SE 440	Project Management	3	3	0	SE 230
NES 595	Special Topics in Network Engineering & Security	3	3	0	Department approval

(\*) Students who are trained in academy or professional training programs in the Faculty of Computer and Information Technology with at least 150 training hours and pass the corresponding international certification exam are exempted from (3 CHs) from other CIT departments.

**Study Plan**

**First Year**

**First Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 101	Calculus I	3	3	0	-
CS 101	Introduction to Programming	3	3	0	CIS 99 or Passing the Computer Skills Exam with a grade of 50% or more
CS 102	Programming Lab	1	0	3	CS 101 or Concurrent
PHY 101	General Physics I	3	3	0	-
ENG 112	English Language 2	3	3	0	Eng 99 or Passing the English Skills Exam with a grade of 50% or more
HSS 110	Social Responsibility	3	2	1	-
HSS 119	Entrepreneurship and Innovation	2	2	0	-
<b>Total</b>		<b>18</b>	<b>16</b>	<b>4</b>	

**Second Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 102	Calculus II	3	3	0	MATH 101
ARB 101	Arabic Language	3	3	0	-
CHEM 103	General Chemistry	3	3	0	-
HSS 129	General Skills	2	2	0	ENG 112
PHY 102	General Physics II	3	3	0	PHY 101
CS 112	Introduction to Object-Oriented Programming	3	3	0	CS 102
CS 113	Object-Oriented Programming Lab	1	0	3	CS 112 or concurrent
<b>Total</b>		<b>18</b>	<b>17</b>	<b>3</b>	

**Second Year**

**First Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 203	Ordinary Differential Equations "1"	3	3	0	MATH 102
EE 212	Electrical Circuits Analysis	3	3	0	PHY 102 + MATH 203 or Concurrent
MATH 241	Discrete Mathematics	3	3	3	-
MATH 201	Intermediate Analysis	3	3	0	MATH 102
PHY 107	General Physics (Lab)	1	0	3	PHY 102
ME 200	Engineering Drawings "A"	1	0	3	CIS 99 or Passing the Computer Skills Exam with a grade of 50% or more
CPE 231	Digital Logic Design	3	3	0	CS 113
<b>Total</b>		<b>17</b>	<b>15</b>	<b>6</b>	

**Second Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
EE 204	Introduction to Linear Systems	3	3	0	MATH 203
EE 213	Electrical Circuits Lab	1	0	3	EE 212
CIS 200	Professional & Ethical Issues in Computing	1	1	0	-
CIS 202	Communication Skills	2	2	0	CIS 200 or concurrent
CIS 201	Introduction to Web Design	1	0	3	CS 113
ME 215	Engineering Mechanics	3	3	0	PHY 101
CPE 232	Digital Logic Design Lab	1	0	3	CPE 231
CPE 252	Computer Organization and Design	3	3	0	CPE 231
CS 211	Data Structures	3	3	0	Passing CS 112 + MATH 241
<b>Total</b>		<b>18</b>	<b>15</b>	<b>9</b>	



**Third Year**

**First Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
EE 260	Signals and Systems Analysis	3	3	0	EE 212 + EE 204 or Concurrent
EE 321	Fundamentals of Electronics (for Non-EE Students)	3	3	0	EE 212
NES 301	Probability and Queuing Theory	3	3	0	MATH 241
CPE 351	Microprocessor Systems	3	3	0	CPE 252
NES 311	Data Communication	3	3	0	CPE 231 + EE 260 or Concurrent
NES 202	Introduction to UNIX	3	3	0	CS 211
<b>Total</b>		<b>18</b>	<b>18</b>	<b>0</b>	

**Second Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
EE 322	Electronic Circuits Lab	1	0	3	EE 213 + EE 321
CIS 221	Fundamentals of Database Systems	3	3	0	CS 211
NES 312	Fundamentals of Computer Networks	3	3	0	NES 311 + NES 301
CPE 352	Computer Architecture	3	3	0	CPE 252
CPE 354	Microprocessor Systems Lab	1	0	3	CPE 232 + CPE 351
MS 100	Military Science	3	3	0	-
<b>Total</b>		<b>14</b>	<b>12</b>	<b>6</b>	

**Fourth Year**  
**First Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
CPE 473	Operating Systems	3	3	0	CPE 352
NES 413	Computer Networks Laboratory	1	0	3	NES 312
NES 415	Networking Protocols	3	3	0	NES 312
NES 451	Basics of Information system Security	3	3	0	NES 301 + NES 311
NES 441	Wireless Networks	3	3	0	NES 312
-	University Elective	3	3	0	-
<b>Total</b>		<b>16</b>	<b>15</b>	<b>3</b>	

**Second Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
NES 442	Wireless Networks Laboratory	1	0	3	NES 441 + NES 413
NES 452	Cryptography and Network Security	3	3	0	NES 312 + NES 451
NES 460	Multimedia Networking	3	3	0	NES 415
NES 470	Network Management	3	3	0	NES 415
NES 416	Network Programming	3	3	0	NES 202 + NES 312 + CPE 473
-	University Elective	3	3	0	-
<b>Total</b>		<b>16</b>	<b>15</b>	<b>6</b>	

**Summer Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
NES 490	Practical Training	3	0	0	Completion of 120 CHs
<b>Total</b>		<b>3</b>	<b>0</b>	<b>0</b>	

**Fifth Year**  
**First Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
NES 553	Network Security Laboratory	1	0	3	NES 452
NES 554	Network Defense	3	3	0	NES 452
NES 591(*)	Graduation Project "1"	1	0	0	Completion of 120 CHs
-	Department Elective	3	3	0	-
-	Department Elective	3	3	0	-
<b>Total</b>		<b>11</b>	<b>9</b>	<b>3</b>	

**Second Semester**

Course ID	Course Name	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
NES 592	Graduation Project "2"	2	0	0	NES 591
-	Department Elective	3	3	0	-
-	Department Elective	3	3	0	-
-	University Elective	3	3	0	-
<b>Total</b>		<b>11</b>	<b>9</b>	<b>-</b>	

(\*) Students must register "NES 591" before the graduation semester (Semester 1 or Semester 2).

## Course Description

### **NES 202: Introduction to UNIX**

**(3C, 3H, 0L)**

*Prerequisite: CS 211*

Basic concepts of Unix, such as processes, files and directories, pipes, input/output redirection, and shells, basic Unix commands and programs, and how to get help, when needed, standard program development tools: editors (EMACS, nano editor), compilers, debuggers, and the “make” facility, automated common system tasks using shell scripts and Perl, basic system administration.

### **NES 301: Probability and Queuing Theory**

**(3C, 3H, 0L)**

*Prerequisite: MATH 241*

Probability principles and sets theory, random variables, operations on random variables, distribution functions, introduction to random processes, Poisson processes and Markov chains, queuing analysis.

### **NES 311: Data Communication**

**(3C, 3H, 0L)**

*Prerequisite: CPE 231, EE 260 or Concurrent*

Analog and digital transmission, modulation and demodulation, transmission media, data encoding, synchronous and asynchronous transmission, digital carriers, error control, multiplexing, circuit and packet switching, open system standards.

### **NES 312: Fundamentals of Computer Networks**

**(3C, 3H, 0L)**

*Prerequisite: NES 311, NES 301*

Network architectures, Application layer protocols: HTTP and FTP, Transmission layer protocols: TCP and UDP, Network Layer services: routing protocols, IPV4 and IPV6, Data link layer services: Error detection and correction, Multiple access Control, Principles of Wireless Networks, Principles of Network Security.

### **NES 413: Computer Networks Laboratory**

**(1C, 0H, 3L)**

*Prerequisite: NES 312*

A set of experiments to design, apply, analyze, and evaluate computer network protocols. Evaluation of static and dynamic routing protocols: RIP, OSPF, and BGP. Evaluation and analysis of TCP and UDP protocols. DHCP and NAT configuration. Analysis of network traffic using sniffing tools.

### **NES 415: Networking Protocols**

**(3C, 3H, 0L)**

*Prerequisite: NES 312*

Essential Internet protocols: ARP, IP, ICMP, IGMP, UDP, TCP, routing protocols such as RIP, OSPF and BGP, multicasting and multicast routing protocols such as DVMRP, MOSPF and PIM, application protocols such as DNS, DHCP, FTP and HTTP.

**NES 416: Network Programming** (3C, 3H, 0L)

*Prerequisite: NES 202, NES 312, CPE 473*

Introduction to Network Programming, Transport Layer Protocols, TCP, UDP, and SCTP, Client-Server Model, TCP Sockets, UDP Sockets, SCTP Sockets, I/O Multiplexing, DNS and Address Conversion, Threads Programming, RPC, Raw Sockets and Datalink Access. One or more of the following Internet Application Protocols and Case Studies: TELNET, HTTP, Authd, SMTP, POP, IMAP, FTP, and Web Programming (CGI, Servlets, and XML).

**NES 441: Wireless Networks** (3C, 3H, 0L)

*Prerequisite: NES 312*

Basic concepts of Wireless Networks: Wireless Personal Area Networks (WPAN), Wireless Local Area Networks (WLAN), and Wireless Wide Area Networks (WWAN). Physical layer standards, medium access control, building and securing WLAN, Wide Area Networks including cellular networks and cellular data networks.

**NES 442: Wireless Networks Laboratory** (1C, 0H, 3L)

*Prerequisite: NES 441, NES 413*

A set of experiments on configuring, implementing, integrating, and testing a variety of wireless technologies. Methods and tools for network management of wireless networks such as WLAN Network Management Systems, Routers, and Switches.

**NES 451: Basics of Information System Security** (3C, 3H, 0L)

*Prerequisite: NES 301, NES 311*

Classical cryptography, substitution ciphers (Shift cipher, Affine cipher, Vigenere cipher, Hill cipher), permutation (transposition) cipher, symmetric cryptography, stream ciphers (RC4, A5/1), block ciphers (DES, 3DES, Rijndael) and their modes of operation. Asymmetric cryptography, Diffie-Hellman key exchange, certificates, basics of public key infrastructure (PKI). Authentication (passwords, biometrics), authorization (Access control lists, capabilities), multi-level security, security modeling, firewalls, CAPTCHA's, intrusion detection systems, software flaws, buffer overflow, viruses, worms, trojan horses, and other forms of malicious code.

**NES 452: Cryptography and Network Security** (3C, 3H, 0L)

*Prerequisite: NES 312, NES 451*

Divisibility and the Greatest Common Divisor, Euclidean Algorithm, modular arithmetic and discrete logarithm, Primes, primality testing, Chinese Remainder Theorem, cipher. Key management and exchange, hash functions (MD5, SHA-1, RIPEMD-160, HMAC), digital signatures, certificates and authentication protocols (X.509, DSS, Kerberos), electronic mail security (PGP, S/MIME), web security, protocols and standards for secure electronic commerce (IPSec, SSL, TLS, SSH, HTTPS, SET).

**NES 460: Multimedia Networking**

**(3C, 3H, 0L)**

*Prerequisite: NES 415*

Multimedia data types: images, video, and audio, multimedia compression technologies such as JPEG, MPEG, and H.264, multimedia protocols including RTP/RTCP and RTSP, Voice-over-IP and its protocols including SIP and H.323, multimedia streaming over best-effort and reservation-based networks, quality-of-service models.

**NES 470: Network Management**

**(3C, 3H, 0L)**

*Prerequisite: NES 415*

Analytical and practical capabilities for computer networks' design, deployment, and management. Basic foundations of network management, the Simple Network Management Protocol in its different versions (SNMPv1, SNMPv2, and SNMPv3), Remote network Monitoring. Telecommunications Management Network (TMN), management tools and statistics measurement, management applications including: configuration, performance, event correlation, security, reports and service levels.

**NES 490: Practical Training**

**(3C)**

*Prerequisites: Completion of 120 credit hours*

Twelve weeks of practical training in an institution that deals with networking and security.

**NES 510: Network Simulation and Modeling**

**(3C, 2H, 1L)**

*Prerequisite: NES 416*

Introduction to simulation concepts, discrete event simulation, random number generation, input modeling; statistical analysis of simulation, computer networks simulation, Discrete time Markov chains (DTMC), Continuous time Markov chains (CTMC), Queuing models (M/M/1, M/M/c/k, M/G/1). Well-known network simulation packages such as ns2 and/or Qualnet.

**NES 540: Wireless Networking Protocols**

**(3C, 3H, 0L)**

*Prerequisite: NES 441*

Challenges and latest solutions in wireless and mobile networks, and ad-hoc and wireless sensor networks, focusing on routing, auto-configuration, clustering, topology management, quality of service (QoS), reliable transport, energy conservation, mobility management, MAC, and service discovery. Existing and proposed standards, and current research projects in this field.

**NES 541: Wireless Networks Security**

**(3C, 3H, 0L)**

*Prerequisite: NES 441, NES 452*

Confidentiality, Privacy, Integrity, Spoofing, Signal intercept, Key management and distribution, control of fraudulent usage of networks. Security of ad-hoc networks, wireless sensor networks, and cellular networks.

**NES 553: Network Security Laboratory**

**(1C, 0H, 3L)**

*Prerequisite: NES 452*

Experiments about conducting attacks against network protocols that include UDP, TCP, ICMP, IP and ARP, traffic sniffing attacks, DNS hacking, SYN flooding, port scanning, access control, intrusion detection systems, and Firewalls.

**NES 554: Computer Network Defense**

**(3C, 3H, 0L)**

*Prerequisite: NES 452*

Internet infrastructure security, denial of service attacks, DNS hacking, Botnets, Ethical hacking principles, footprinting, scanning, enumeration, computer network defense and countermeasures including: IP traceback, router Security, Intrusion detection and prevention systems, firewalls, and virtual private networks.

**NES 580: High-Speed Networks**

**(3C, 3H, 0L)**

*Prerequisite: NES 415*

High-speed network architectures, protocols and control algorithms. Basic architecture of packet networks and their network elements (switches, routers, bridges), and protocols used to enable transmission of packets through network. Network protocols: Ethernet, Internet, token rings, FDDI, Circuit-switched networks, ATM networks, switching, scheduling, naming, and addressing, routing, error control, flow control, traffic collection, modeling, and characterization, traffic management, connection admission control algorithms, and congestion control algorithms.

**NES 591: Graduation Project 1**

**(1C)**

*Prerequisite: Completion of 120 credit hours*

The student should get familiar with the theoretical and practical aspects associated with the subject matter of the project.

**NES 592: Graduation Project 2**

**(2C)**

*Prerequisite: NES 591*

The student implements, tests, and presents the project proposed in Graduation Project 1 course.

**NES 595: Special Topics in Network Engineering and Security**

**(3C)**

*Prerequisite: Department Approval*

Selected state-of-the-art topics in network engineering and security.