



## **Course Curriculum for Master Degree in Network Engineering and Security**

The Master Degree in Network Engineering and Security is awarded by the Faculty of Graduate Studies at Jordan University of Science and Technology (JUST) upon the fulfillment of the following requirements:

1. Compliance with the J.U.S.T. Master Degree regulations approved by the Dean Council (No. 492/2006), dated 8/8/2006.
2. Successful completion of (34) credit hours in one of the following tracks:

### **First: Thesis Track**

#### **1. Compulsory Requirements: (16) credit hours as follows:**

| <b>Course Code</b> | <b>Course Name</b>                          | <b>Credit Hours</b> |
|--------------------|---|---------------------|
| NES 711            | Advanced Algorithms                         | 3                   |
| NES 712            | Performance Evaluation of Computer Networks | 3                   |
| NES 741            | Advanced Wireless Networks                  | 3                   |
| NES 750            | Advanced Network Security                   | 3                   |
| NES 751            | Advanced Cryptography                       | 3                   |
| NES 780            | Seminar in Network Engineering and Security | 1                   |

#### **2. Elective Requirements: (9) credit hours from the following\*:**

| <b>Course Code</b> | <b>Course Name</b>                                 | <b>Credit Hours</b> |
|--------------------|--|---------------------|
| NES 740            | Wireless Sensor Networks                           | 3                   |
| NES 752            | Intrusion Analysis and Incident Management         | 3                   |
| NES 753            | Digital Forensics                                  | 3                   |
| NES 754            | Smartphone Application Security                    | 3                   |
| NES 755            | Web Applications Security                          | 3                   |
| NES 760            | Multimedia Network Security                        | 3                   |
| NES 761            | Advanced Multimedia Networking                     | 3                   |
| NES 770            | Distributed Systems                                | 3                   |
| NES 771            | Peer-to-Peer Systems                               | 3                   |
| NES 772            | Mobile and Pervasive Computing                     | 3                   |
| NES 773            | Software Defined Networking                        | 3                   |
| NES 779            | Special Topics in Network Engineering and Security | 3                   |

\* The student may study no more than 3 credit hours from courses of 700 or 800 level offered by other programs related to his field of study upon approval of the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.

**3. Master Thesis (NES 799): Total of 9 credit hours as follows:**

| Course Code | Course Name   | Credit Hours |
|-------------|---------------|--------------|
| NES 799 A   | Master Thesis | 9            |
| NES 799 B   | Master Thesis | 6            |
| NES 799 C   | Master Thesis | 3            |
| NES 799 D   | Master Thesis | 0            |

**Second: Non-Thesis Track**

**1. Compulsory Requirements: (25) credit hours**

| Course Code | Course Name                                 | Credit Hours |
|-------------|---|--------------|
| NES 711     | Advanced Algorithms                         | 3            |
| NES 712     | Performance Evaluation of Computer Networks | 3            |
| NES 741     | Advanced Wireless Networks                  | 3            |
| NES 750     | Advanced Network Security                   | 3            |
| NES 751     | Advanced Cryptography                       | 3            |
| NES 752     | Intrusion Analysis and Incident Management  | 3            |
| NES 761     | Advanced Multimedia Networking              | 3            |
| NES 770     | Distributed Systems                         | 3            |
| NES 780     | Seminar in Network Engineering and Security | 1            |

**2. Elective Requirements: (9) credit hours from the following \*:**

| Course Code | Course Name  | Credit Hours |
|-------------|--|--------------|
| NES 740     | Wireless Sensor Networks                           | 3            |
| NES 753     | Digital Forensics                                  | 3            |
| NES 754     | Smartphone Application Security                    | 3            |
| NES 755     | Web Applications Security                          | 3            |
| NES 760     | Multimedia Network Security                        | 3            |
| NES 771     | Peer-to-Peer Systems                               | 3            |
| NES 772     | Mobile and Pervasive Computing                     | 3            |
| NES 773     | Software Defined Networking                        | 3            |
| NES 779     | Special Topics in Network Engineering and Security | 3            |

\* The student may study no more than 3 credit hours from courses of 700 or 800 level offered by other programs related to his field of study upon approval of the Dean of Graduate Studies based on the recommendation of the departmental graduate studies committee.

**3. Passing the Comprehensive Exam (NES 798): zero credit hour.**

## Course Descriptions

### **NES 711 Advanced Algorithms: (3 Credit Hours)**

This course handles the strategies of algorithms synthesis and analysis. It covers design methodologies of classical algorithm categories such as: divide-and-conquer, greedy method, dynamic programming, search and traversal, backtracking, and branch-and-bound. Topics also include computational complexity and important theoretical results from lower-and upper-bound studies, NP-hard, and NP-complete problems.

### **NES 712 Performance Evaluation of Computer Networks: (3 Credit Hours)**

This course covers the application of probability theory to computer networks. Random processes, Little's theorem, birth-death processes, Markov chains, Multidimensional Markov chains, M/M/1, M/M/m, M/M/m/m, M/G/1 and G/G/1 queuing systems and their applications in computer networks. Loss models such as Erlang loss model and Engset loss model, Insensitivity and Generalization of loss models. Conservation laws, priority queues, and polling models. Traffic models such as Markovian traffic models and Long-Range Dependent (LRD) traffic models. Discrete event simulations, generation of random variables, variance reduction techniques and general purpose simulation languages.

### **NES 740 Wireless Sensor Networks: (3 Credit Hours)**

This course covers wireless sensor networking, location awareness, power management, sensor networking standards and applications, sensor network hardware/software co-design, algorithms for self-configuration and adaptation, collaborative data aggregation and processing, and tasking and programming. Both existing and proposed wireless sensor networking standards/protocols will be covered, as well as current research projects in this field.

### **NES 741 Advanced Wireless Networks: (3 Credit Hours)**

This is an advanced-level course on wireless networks and its recent challenges and developments. It covers the principles of recent wireless networking technologies with emphasis on algorithms, protocols, and implementation aspects of advanced wireless services. Most of the course material will be covered via state-of-the-art research papers.

### **NES 750 Advanced Network Security: (3 Credit Hours)**

This course covers advanced aspects of network security. Topics include: historical and recent network-based attacks including denial of service attacks, DNS Security, Intrusion Detection and Prevention Systems; Advanced firewall considerations; Network cryptographic protocols (IPsec), Key distribution and Management protocols (IKE), web security, and contemporary network security topics.

### **NES 751 Advanced Cryptography: (3 Credit Hours)**

This course covers advanced aspects of cryptography based on a formal and theoretical approach. Topics covered include: number theory concepts, Exponentiation methods, Chinese remainder theorem, Polynomials and finite fields, Factoring and generating prime numbers, primality testing, discrete logarithm, birthday problem, secure hash functions, attacks on hash functions, digital signature and their attacks, pseudorandom generators, and Zero-knowledge proofs.

**NES 752 Intrusion Analysis and Incident Management: (3 Credit Hours)**

This course focuses on Intrusion Detection, Intrusion Prevention, and Incident Handling. Topics include an analysis of the principles and practices of intrusion detection, intrusion prevention, and incident handling, identifying attack patterns; deployment of resources and responses to handle the incident, surveillance, damage assessment, risk assessment, data mining, attack tracing, system recovery, and continuity of operation.

**NES 753 Digital Forensics: (3 Credit Hours)**

This course covers the fundamentals of digital forensics, forensic duplication and analysis, network surveillance, acquiring, authenticating and analyzing digital evidence, Data Retention, Data Disposal, Litigation, Internal Investigations, Incident Response, commercial and open source forensic software programs.

**NES 754 Smartphone Application Security: (3 Credit Hours)**

This course covers different aspects of smartphone security. The course covers design and implementation of selected software attacks (ethical hacking), design and implementation of secure user apps, and system programming in general.

**NES 755 Web Applications Security: (3 Credit Hours)**

The primary objective of this course is to study fundamental techniques in developing secure web based applications, including vulnerability of web based applications and how to protect those applications from attacks. In addition, advanced topics related to Web, such as E-commerce security, Web 2.0, collaborative web-based applications, web server security, application-level security and web database security.

**NES 760 Multimedia Network Security: (3 Credit Hours)**

This course discusses topics related to secure transmission or distribution of multimedia content, including images, video and audio. The course covers secure multimedia communication including multimedia encryption, authentication, digital watermarking, digital fingerprinting, access control, visual cryptography, multimedia data hiding in images, video, and audio, steganography and steganalysis.

**NES 761 Advanced Multimedia Networking: (3 Credit Hours)**

This course focuses on multimedia communications in wired and wireless networks. The course covers multimedia streaming algorithms, peer-to-peer streaming technologies, media on demand, scalable multimedia coding and communication, multimedia routing protocols, cross layer design for multimedia transmission, wireless multimedia streaming, and multimedia sensor networks.

**NES 770 Distributed Systems: (3 Credit Hours)**

This course describes the underlying principles for designing and implementing highly available, highly reliable systems that execute on multiple networked machines. Specific topics include introduction, definition and characterization of distributed systems, architectural styles, processes and communication, naming, synchronization and mutual exclusion, consistency and replication, and fault tolerance and distributed transactions. One or more contemporary case studies will be elaborated upon, e.g., distributed file systems,

distributed objects, web services, data centers and cloud computing, content-distributed networks, and overlay networks.

**NES 771 Peer-to-Peer Systems: (3 Credit Hours)**

The course describes the emergence of peer-to-peer systems as an important architectural model for building available, reliable, and anonymous distributed applications. The course covers both theoretic and practical principles underlying the design and implementation of peer-to-peer systems. The course starts by introducing the very early examples to the most new ones, e.g., Napster, KaZaA, Kademia, Gnutella, Bittorrent, and Skype. The course covers the relevant issues of peer-to-peer systems including placement of data, routing, searching, load balancing, security and trust, and applications. The course contrasts the two viewpoints to address these issues: the structured and unstructured schools of thought.

**NES 772 Mobile and Pervasive Computing: (3 Credit Hours)**

This course studies the mechanisms and environments of pervasive computing. Topics include computer and network architectures for pervasive computing, mobile computing mechanisms, human-computer interaction using speech and vision, pervasive software systems, location mechanisms, practical techniques for security and user-authentication, and experimental pervasive computing systems.

**NES 773 Software Defined Networking (3 Credit Hours)**

This course covers SDN software stack, SDN abstractions: protocol independent forwarding, composition and trace tree, verification, SDN applications: traffic engineering, wireless networks, virtualization, debugging, and security. Topics also include open flow controller and switch design, network programming, correctness, and debugging, network services, and network optimization.

**NES 779 Special Topics in Network Engineering and Security: (3 Credit Hours)**

This course covers a specific topic in network engineering and security selected by the instructor and studied in depth in class.

**NES 780 Seminar in Network Engineering and Security: (1 Credit Hour)**

The course investigates the latest advances in network engineering and security. It requires students to convert written research articles and technical material into a persuasive oral presentation. Students are expected to engage in an iterative process of studying, critically analyzing and discussing, summarizing, and presenting selected research articles and topics.

**NES 798 Comprehensive Exam: (Zero Credit Hours)**

In this course the student will set for an exam that includes all topics addressed throughout his academic program. Comprehensive exam will be held inside the Faculty of Information Technology under the supervision of specialized faculty members.

**NES 799 Master Thesis: (9 Credit Hours)**

Individual research under the direction of a faculty member(s) and committee, leading to preparation, completion, and oral defense of a thesis.

## Study Plan (Thesis Track)

### First semester / First year

| Course Code  | Course Name                                 | Credit Hours |
|--------------|---|--------------|
| NES 711      | Advanced Algorithms                         | 3            |
| NES 741      | Advanced Wireless Networks                  | 3            |
| NES 780      | Seminar in Network Engineering and Security | 1            |
| <b>Total</b> |   | <b>7</b>     |

### Second semester / First year

| Course Code  | Course Name                                 | Credit Hours |
|--------------|---|--------------|
| NES 712      | Performance Evaluation of Computer Networks | 3            |
| NES 750      | Advanced Network Security                   | 3            |
|              | Elective Course                             | 3            |
| <b>Total</b> |   | <b>9</b>     |

### First semester / Second year

| Course Code  | Course Name           | Credit Hours |
|--------------|-----------------------|--------------|
| NES 751      | Advanced Cryptography | 3            |
|              | Elective Course       | 3            |
|              | Elective Course       | 3            |
| <b>Total</b> |                       | <b>9</b>     |

### Second semester / Second year

| Course Code  | Course Name   | Credit Hours |
|--------------|---------------|--------------|
| NES 799 A    | Master Thesis | 9            |
| <b>Total</b> |               | <b>9</b>     |

## Study Plan (Non-Thesis Option)

### First semester / First year

| Course Code  | Course Name                                 | Credit Hours |
|--------------|---|--------------|
| NES 711      | Advanced Algorithms                         | 3            |
| NES 741      | Advanced Wireless Networks                  | 3            |
| NES 780      | Seminar in Network Engineering and Security | 1            |
| <b>Total</b> |   | <b>7</b>     |

### Second semester / First year

| Course Code  | Course Name                                 | Credit Hours |
|--------------|---|--------------|
| NES 712      | Performance Evaluation of Computer Networks | 3            |
| NES 750      | Advanced Network Security                   | 3            |
|              | Elective Course                             | 3            |
| <b>Total</b> |   | <b>9</b>     |

### First semester / Second year

| Course Code  | Course Name                    | Credit Hours |
|--------------|--------------------------------|--------------|
| NES 751      | Advanced Cryptography          | 3            |
| NES 761      | Advanced Multimedia Networking | 3            |
|              | Elective Course                | 3            |
| <b>Total</b> |                                | <b>9</b>     |

### Second semester / Second year

| Course Code  | Course Name                                | Credit Hours |
|--------------|--|--------------|
| NES 752      | Intrusion Analysis and Incident Management | 3            |
| NES 770      | Distributed Systems                        | 3            |
|              | Elective Course                            | 3            |
| <b>Total</b> |  | <b>9</b>     |