ECE 297:11
Reconfigurable Architectures for Computer Security

Course web page:

http://mason.gmu.edu/~kgaj/ECE297

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Most-related GMU courses

ECE 646
Cryptography and Computer Network Security

ECE 746
Secure Telecommunication Systems

ECE 545
Introduction to VHDL

ECE 645
Computer Arithmetic

Cryptography and Computer Network Security

- Historical ciphers
- **Classical encryption (DES, IDEA, RC5, AES)**
- **Public key encryption (RSA)**
- Message authentication and Hash functions
- Digital signatures
- Public key certificates
- Secure Internet Protocols
  - e-mail: PGP and S-MIME
  - www: SSL
- Cryptographic standards

- Key escrow encryption
- Quantum cryptography

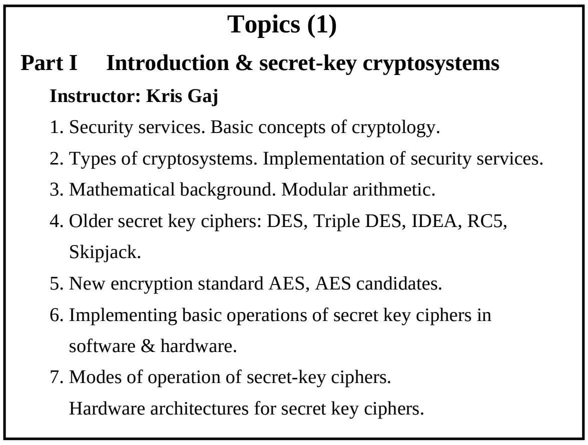
Secure Telecommunication Systems

- Stream ciphers
- **Elliptic curve cryptosystems**
- Smart cards and PCMCIA cards
- Attacks against implementations (timing, power analysis)
- **Efficient and secure implementations of cryptography**
- Security in various kinds of networks (IPSec, ATM, wireless)
- Passwords, authentication tokens
- Zero-knowledge identification schemes

- Biometric methods

Specific to this course

- supports research rather than competes with the research
- intense
- project oriented
- flexible
- extendible into future thesis and sponsored-research work

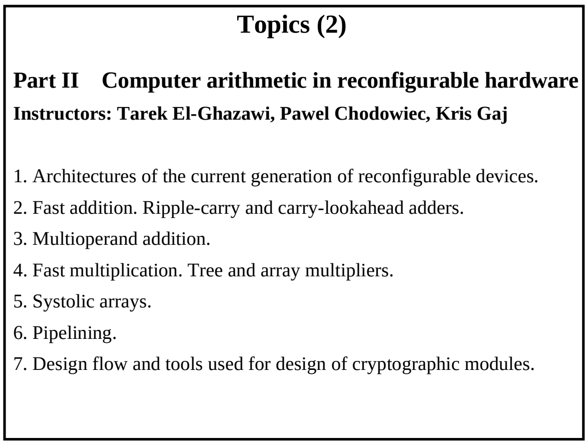


Topics (1)

Part I Introduction & secret-key cryptosystems

Instructor: Kris Gaj

1. Security services. Basic concepts of cryptology.
2. Types of cryptosystems. Implementation of security services.
3. Mathematical background. Modular arithmetic.
4. Older secret key ciphers: DES, Triple DES, IDEA, RC5, Skipjack.
5. New encryption standard AES, AES candidates.
6. Implementing basic operations of secret key ciphers in software & hardware.
7. Modes of operation of secret-key ciphers.
   Hardware architectures for secret key ciphers.

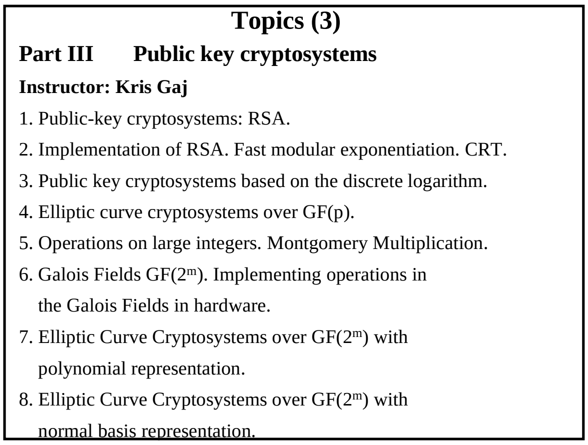


Topics (2)

Part II Computer arithmetic in reconfigurable hardware

Instructors: Tarek El-Ghazawi, Pawel Chodowiec, Kris Gaj

1. Architectures of the current generation of reconfigurable devices.
2. Fast addition. Ripple-carry and carry-lookahead adders.
3. Multioperand addition.
4. Fast multiplication. Tree and array multipliers.
5. Systolic arrays.
6. Pipelining.
7. Design flow and tools used for design of cryptographic modules.



Topics (3)

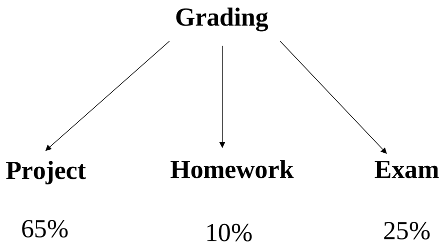
Part III Public key cryptosystems

Instructor: Kris Gaj

1. Public-key cryptosystems: RSA.
2. Implementation of RSA. Fast modular exponentiation. CRT.
3. Public key cryptosystems based on the discrete logarithm.
4. Elliptic curve cryptosystems over GF(p).
5. Operations on large integers. Montgomery Multiplication.
6. Galois Fields GF(2^m). Implementing operations in the Galois Fields in hardware.
7. Elliptic Curve Cryptosystems over GF(2^m) with polynomial representation.
8. Elliptic Curve Cryptosystems over GF(2^m) with normal basis representation.

Proposed schedule (1)

• Lecture Part I	- June 3 - June 13
• Project I	- June 15 - July 19
• Lecture Part II	- TBD
• Exam	- July 15
• Final Project I presentations & reports	- July 19
• **Grading**	**- July 22**
• Lecture Part III	- July 22-August 1
• Project II	- August 1 - August 23
• Final Project II presentations & reports	- TBD



Project

- groups of 1-3 students
- topics suggested by the instructors
- implementation of a cryptosystem in reconfigurable hardware using VHDL or Verilog HDL
- HDL code
  - fully verified using available test vectors and public domain software implementations of cryptographic algorithms.
  - experimentally tested using FPGA board, such as SLAAC-1V or Firebird, or reconfigurable hypercomputer.

Resources

- Standards & specifications
  - NIST Cryptographic Toolkit
  - AES
  - IEEE P1363
- Software cryptographic libraries
  - Crypto++
  - MIRACL
- FPGA resources
- Cryptographic dictionary

Cryptographic dictionary project

- English
- Polish
- French

- Arabic
- Vietnamese
- Hindi
- Nepali
- ?

Handling the code

- export restrictions
- no hardware cryptographic modules in public domain
- protection access to your code
- transfer of codes on diskettes and using PGP
- rules regarding sharing the codes