MODERN CRYPTOGRAPHY
Bachelor Computer Science, University of Amsterdam, 2017/18
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Problem Set 3

We will work on the following exercises together during the work sessions on Tuesday.

The last questions are marked as homework exercises. Your homework must be handed in within one week **electronically via Canvas before Thursday, 14 September 2017, 20:00h**. This deadline is strict and late submissions are graded with a 0. At the end of the course, the lowest of all the homework grades will be dropped.

You are strongly encouraged to work together on the exercises, including the homework. However, after this discussion phase, you have to write down and submit your own individual solution.

Problem 1: Exercise 3.1 from [KL]

Prove Proposition 3.6: Let negl_1 and negl_2 be negligible functions. Then,

1. The function negl_3 defined by $\mathsf{negl}_3(n) = \mathsf{negl}_1(n) + \mathsf{negl}_2(n)$ is negligible.

2. For any positive polynomial p, the function negl_4 defined by $\mathsf{negl}_4(n) = p(n) \cdot \mathsf{negl}_1(n)$ is negligible.

Problem 2: Exercise 3.2 from [KL]

Prove that Definition 3.8 cannot be satisfied if Π can encrypt arbitrary-length messages and the adversary is not restricted to output equal-length messages in experiment $\mathsf{PrivK}^{\mathsf{eav}}_{\mathcal{A},\Pi}$. **Hint:** Let $q(n)$ be a polynomial upper-bound on the length of the cipher-text when Π is used to encrypt a single bit. Then consider an adversary who outputs $m_0 \in \{0,1\}$ and a uniform $m_1 \in \{0,1\}^{q(n)+2}$.

Problem 3: Exercise 3.3 from [KL]

Say $\Pi = (\mathsf{Gen}, \mathsf{Enc}, \mathsf{Dec})$ is such that for $k \in \{0,1\}^n$, algorithm Enc_k is only defined for messages of length at most $\ell(n)$ (for some polynomial ℓ). Construct a scheme satisfying Definition 3.8 even when the adversary is *not* restricted to outputting equal-length messages in $\mathsf{PrivK}^{\mathsf{eav}}_{\mathcal{A},\Pi}$.

Problem 4: Exercise 3.4 from [KL]

Prove the equivalence of Definition 3.8 and Definition 3.9 from the book [KL].