**Math 241, Introduction to Abstract Algebra – Fall 2019**
**Course website:** `https://sites.aub.edu.lb/kmakdisi/`
**Problem set 10, due Wednesday, December 11 at the beginning of class**

**Extra lecture:** We have an extra lecture this Saturday, December 7, from 10am–12 noon in **Nicely 415** (the large lecture room where you have recitations).

**Exercises from Fraleigh:**
Section 19, exercises 9, 14, 29.
Section 26, exercises 12, 13, 14, 22, 37.
Section 27, exercises 2, 4, 24 (Refer to Theorem 19.11), 28, 34, 35.

**Additional Exercises (also required):**

**Exercise A10.1:** a) Prove (by induction on $n$) the binomial theorem for commutative rings: If $R$ is commutative, and $a, b \in R$, then for $n \geq 1$ we have

$$(a+b)^n = \sum_{i=0}^{n} \binom{n}{i} \cdot a^{n-i} b^i,$$

where $\binom{n}{i} = \frac{n!}{i!(n-i)!} \in \mathbf{Z}$, and for $m \in \mathbf{Z}$ and $c \in R$, we define $m \cdot c \in R$ in the obvious way.

b) What happens if $R$ is not commutative? Expand $(a+b)^2$ and $(a+b)^3$ completely, without assuming commutativity.

**Look at, but do not hand in:**
Section 19, exercises 1, 2, 3, 4, 8, 11, 12, 19, 23, 30.
Section 20, exercise 11, 12, 13, 14, 27, 28.
Section 21, exercises 1, 2, 6–11, 12, 17.
Section 26, exercises 5, 6, 7, 11, 16, 17, 20, 26, 27, 29, 30, 31.