**Expressions Related to the Roots of Polynomials**

 **Sums of squares**:

* Quadratic: $α^{2}+β^{2}=\left(α+β\right)^{2}-2αβ$
* Cubic: $α^{2}+β^{2}+γ^{2}=\left(α+β+γ\right)^{2}-2(αβ+βγ+γα)$
* Quartic: $α^{2}+β^{2}+γ^{2}+δ^{2}=\left(α+β+γ+δ\right)^{2}-2(αβ+ αβ+αγ+βγ+…)$

**Sums of cubes**:

* Quadratic: $α^{3}+β^{3}=\left(α+β\right)^{3}-3αβ\left(α+β\right)$
* Cubic: $α^{3}+β^{3}+γ^{3}=\left(α+β+γ\right)^{3}-3\left(α+β+γ\right)\left(αβ+ βγ+γα\right)+3αβγ$

**Reciprocals:**

* Quadratic: $\frac{1}{α}+\frac{1}{β}=\frac{α+β}{αβ}$
* Cubic: $\frac{1}{α}+\frac{1}{β}+\frac{1}{γ}=\frac{αβ+βγ+γα}{αβγ}$
* Quartic: $\frac{1}{α}+\frac{1}{β}+\frac{1}{γ}+\frac{1}{δ}=\frac{Σαβγ}{αβγδ}$

**Products of Powers**

* Quadratic: $α^{n}+β^{n}=\left(αβ\right)^{n}$
* Cubic: $\left(α+β+γ\right)^{n}=(αβγ)^{n}$
* Quartic: $\left(α+β+γ+δ\right)^{n}=(αβγδ)^{n}$

**Example**

**The three roots of a cubic equation are** $α,β$ **and** $γ$**. Given that** $αβγ=4$**,** $αβ+βγ+γα=-5$ **and** $α+β+γ=3$**, find the value of**

$$\left(α+3\right)\left(β+3\right)(γ+3)$$

Ex 4D pg 63-64