Roots of Polynomials

If $ax^2+bx+c=0$ has roots α, β

$$a(x-\alpha)(x-\beta)=0$$

$$a\left(x^2-(\alpha+\beta)x+\alpha\beta\right)=0$$

$$ax^2-a(\alpha+\beta)x+a\alpha\beta$$

$a=a$ $\quad \therefore \quad \alpha+\beta=\frac{-b}{a}$

$b=-a(\alpha+\beta)$

$c=a\alpha\beta \quad \alpha\beta=\frac{c}{a}$

If $ax^3+bx^2+cx+d=0$ has roots α, β, γ

$$a(x-\alpha)(x-\beta)(x-\gamma)=0$$

$$a\left(x^3-x^2(\alpha+\beta+\gamma)+x(\alpha\beta+\alpha\gamma+\beta\gamma)-\alpha\beta\gamma\right)=0$$

$a=a$ $\quad \therefore \quad -\frac{b}{a}=(\alpha+\beta+\gamma)$

$b=-a(\alpha+\beta+\gamma)$

$c=a(\alpha\beta+\alpha\gamma+\beta\gamma) \quad \frac{c}{a}=\alpha\beta+\alpha\gamma+\beta\gamma$

$d=-a\alpha\beta\gamma \quad -\frac{d}{a}=\alpha\beta\gamma$

If $ax^4 + bx^3 + cx^2 + dx + e = 0$ has roots $\alpha, \beta, \gamma, \delta$,

$$\alpha + \beta + \gamma + \delta = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \alpha\delta + \beta\gamma + \beta\delta + \gamma\delta = \Sigma\alpha\beta = \frac{c}{a}$$

$$\alpha\beta\gamma + \alpha\beta\delta + \alpha\gamma\delta + \beta\gamma\delta = \Sigma\alpha\beta\gamma = -\frac{d}{a}$$

$$\alpha\beta\gamma\delta = \frac{e}{a}$$