# Rules of finding complementary functions

**Case 1:** Roots are real and different

$$(D-m_1)(D-m_2) \cdots (D-m_n)y = 0$$

$$Y = c_1 e^{m_1 x} + c_2 e^{m_2 x} + \cdots + c_n e^{m_n x}$$

**Case 2:** Roots are equal

$$m_1 = m_2$$

$$C.F = (c_1 + c_2) e^{m_1 x} + (c_3 + c_4)^{m_2 x} + \cdots$$

**Case 3:** Roots are imaginary

$$m_1 = \alpha \pm i\beta$$

$$C.F = c_1 e^{(\alpha + i\beta)x} + c_2 e^{(-\alpha - i\beta x)} + \cdots c_n e^{m_n x}$$

$$C.F = e^{\alpha x}(c_1 \cos \beta x + c_2 \sin \beta x) + \cdots$$

**Case 4:** 2 roots of imaginary are equal

$$C.F = e^{\alpha x}((c_1 x + c_2) \cos \beta x + (c_3 x + c_4) \sin \beta x)$$