

Here is to get the result manually. It's a part of very long process but I am just concerned in converting prior equation to the former.

$$u'' = a_0 + a_1u + a_2u^2$$

Multiplying by  $u'$  on both side and integrating we have

$$\int u''u' = \int a_0u' + a_1uu' + a_2u^2u'$$

$$\frac{(u')^2}{2} = 2a_0u + \frac{a_1u^2}{2} + \frac{a_2u^3}{3} + d1$$

Multiplying 2 on both sides

$$(u')^2 = 2a_0u + a_1u^2 + \frac{2a_2u^3}{3} + d$$