8.8.1 Forward Euler method

MO2.4 MO2.7

We now consider our first numerical method for solving an IVP, the forward Euler method. The key concept is that from the governing differential equation, given some current state $\underline{v}$ at time t we can always calculate the rate of change from the model differential equation $\mathrm{d}\underline{u}/\mathrm{d}t = \underline{f}(\underline{v}, t)$. Since we know the initial condition, we can then start from it, calculate the $\mathrm{d}\underline{u}/\mathrm{d}t\,(t_I) = \underline{f}(\underline{u}_I, t_I)$ and then use that slope to extrapolate the solution to time $t^1 = t_I + \Delta t$. This is shown graphically in Figure 8.13. Mathematically, this gives

$$\underline{v}^1 = \underline{u}(t_I) + \Delta t \underline{f}(\underline{u}(t_I), t_I). \tag{8.56}$$

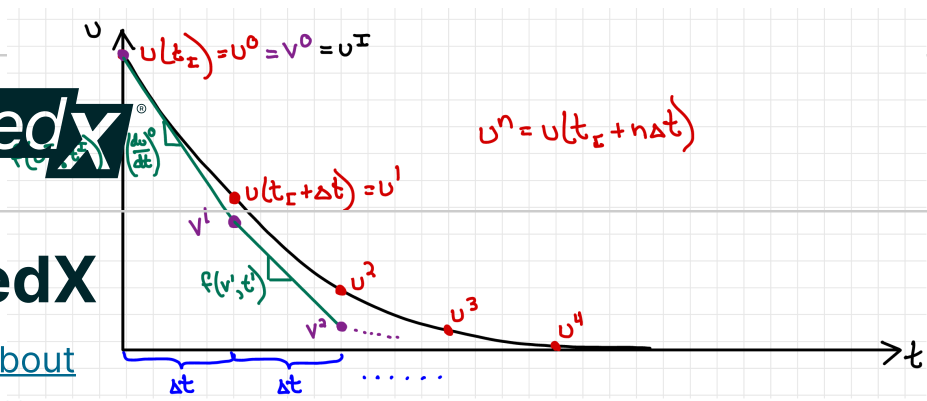


Figure 8.13: Forward Euler method

Now, to find $\underline{v}^2$, we can use the same idea to calculate the rate of change from $\underline{f}(\underline{v}^1, t^1)$ and extrapolate again,

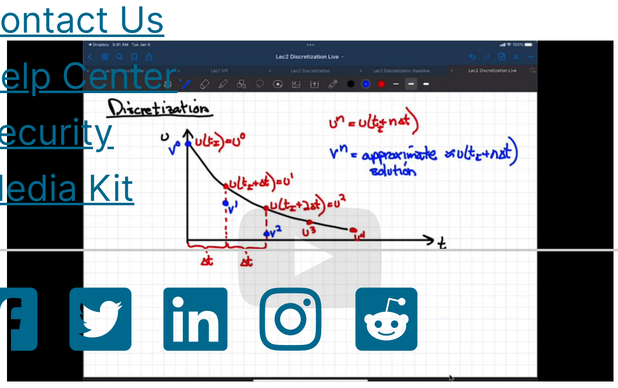
$$\underline{v}^2 = \underline{v}^1 + \Delta t \underline{f}(\underline{v}^1, t^1) \tag{8.57}$$

Then, this process of extrapolation can be continued. Thus, the Forward Euler algorithm is,

$$\underline{v}^0 = \underline{u}_I \tag{8.58}$$

$$\underline{v}^{n+1} = \underline{v}^n + \Delta t \underline{f}(\underline{v}^n, t^n) \quad \text{for} \quad n \geq 0, \tag{8.59}$$

Video deriving the Forward Euler method



INSTRUCTOR: So how do we approximate these values of v in our numerical method?

We're going to look at probably what is the simplest

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