HITO 1

- Euler: $U^{n+1} = U^n + \Delta t\, F(U^n)$

- Runge-Kutta 4: $U^{n+1} = U^n + \frac{\Delta t}{6}\left(k_1 + 2k_2 + 2k_3 + k_4\right)$

  $k_1 = F(t, U^n)$; $k_2 = F\left(t + \frac{\Delta t}{2}, U^n + k_1 \frac{\Delta t}{2}\right)$

  $k_3 = F\left(t + \frac{\Delta t}{2}, U^n + k_2 \frac{\Delta t}{2}\right)$; $k_4 = F(t + \Delta t, U^n + k_3 \Delta t)$

- Crank-Nicholson: $U^{n+1} = U^n + \frac{\Delta t}{2}\left(F(U^n) + F(U^{n+1})\right)$

  Idea: Método iterativo. Correr varias veces el algoritmo en un mismo t, con $U^{n+1} = U^n$ en la 1ª iteración

  Solución del profe:

  - Si F es lineal: $F(U^{n+1}) = A\,U^{n+1}$

    $U^{n+1} = U^n + \frac{\Delta t}{2}\left(F(U^n) + F(U^{n+1})\right)$; $\left(I - \frac{\Delta t}{2}A\right)U^{n+1} = \left(I + \frac{\Delta t}{2}A\right)U^n$;

    $$\boxed{U^{n+1} = \left(I - \frac{\Delta t}{2}A\right)^{-1}\left(I + \frac{\Delta t}{2}A\right)U^n}$$

  - Si F es no lineal: $G(x) = x - U^n - \frac{\Delta t}{2}\left(F(U^n) + F(x)\right)$

    Hay que buscar los ceros de $G(x)$: Newton-Raphson

    $$\boxed{U^{n+1} = \text{Newton}(\text{func} = G,\ x0 = U^n)}$$