Newmark's Full Formula

$$u_{t+1} = u_t + \dot{u}_t \Delta t + \left(\frac{1}{2} - \beta\right)\Delta t^2 \ddot{u}_t + \beta \Delta t^2 \ddot{u}_{t+1}$$

$$\dot{u}_{t+1} = \dot{u}_t + (1-\gamma)\Delta t \ddot{u}_t + \gamma \Delta t \ddot{u}_{t+1}$$

... we then

$$\ddot{u}_{t+1} = \frac{1}{\beta \Delta t^2}\Delta u - \frac{1}{\beta \Delta t}\dot{u}_t - \left(\frac{1}{2\beta} - 1\right)\ddot{u}_t$$

$$\dot{u}_{t+1} = \frac{\gamma}{\beta \Delta t}\Delta u + \left(1 - \frac{\gamma}{\beta}\right)\dot{u}_t + \left(1 - \frac{\gamma}{2\beta}\right)\Delta t \ddot{u}_t$$

Replacing in Eq. Equations:

$$\Pi\left[\frac{1}{\beta \Delta t^2}\Delta u - \frac{1}{\beta \Delta t}\dot{u}_t - \left(\frac{1}{2\beta} - 1\right)\ddot{u}_t\right] + C\left[\frac{\gamma}{\beta \Delta t}\Delta u + \left(1 - \frac{\gamma}{\beta}\right)\dot{u}_t + \left(1 - \frac{\gamma}{2\beta}\right)\Delta t \ddot{u}_t\right]$$

$$\Delta u = u_{t+1} - u_t$$

$$M\left[\frac{1}{\beta \Delta t^2}u_{t+1} - \frac{1}{\beta \Delta t^2}u_t - \frac{1}{\beta \Delta t}\dot{u}_t - \left(\frac{1}{2\beta} - 1\right)\ddot{u}_t\right] + C\left[\frac{\gamma}{\beta \Delta t}u_{t+1} - \frac{\gamma}{\beta \Delta t}u_t + \left(1 - \frac{\gamma}{\beta}\right)\dot{u}_t + \left(1 - \frac{\gamma}{2\beta}\right)\Delta t \ddot{u}_t\right] + K u_{t+1} = F$$

Eq. Equations

$$m\ddot{u} + C\dot{u} + Ku = F$$

$$\underbrace{\left[\Pi \cdot \frac{1}{\rho \Delta t^2} + C \frac{r}{\rho \Delta t} + K\right]}_{\tilde{K}} u_{t+1} = F + \Pi \left[\frac{1}{\rho \Delta t^2} u_t + \frac{1}{\rho \Delta t} \dot{u}_t + \left(\frac{1}{2\rho} - 1\right) \ddot{u}_t\right]$$

$$C\left[\frac{r}{\rho \Delta t} u_t - \left(1 - \frac{r}{\rho}\right) \dot{u}_t - \left(\frac{r}{2\rho} - 1\right) \Delta t \ddot{u}_t\right]$$