**NPTEL course offered by IIT Madras**
**Computer methods of analysis of offshore structures**

**Tutorial 10: Offshore platforms: Dynamic analyses**

**Answer all questions** **Total marks: 25**

1. Explain Numerical integration scheme used to solve a dynamic system?

Equation is integrated using Numerical method
- step-by-step procedure

- 'Direct' means "No transformation of Equation into different forms" is done prior to the numerical integration

- All integration schemes ( numerical methods, in general) - conditional stability

- Integration scheme suggested by Newmark is unconditionally stable when the time step used is smaller than critical value

i.e. $\Delta t \leq \Delta t_{cr}$

$\Delta t_{cr} = T_n/\pi$ where n is the order of the element of the system

$T_n$ is the smallest (largest) period of the system

Analogy
(i) Equation is not tried (solved) @ any instant of time t
But
it is aimed to satisfy the Equation @ discrete time points within the interval of solution

(ii) Variation in the (displacement, vel, acc) within each time interval is assumed.

Mathematically, following Eqns are valid

$$\ddot{u}_{t+\Delta t} = \ddot{u}_t + \left[(1-\delta)\ddot{u}_t + \delta \ddot{u}_{t+\Delta t}\right]\Delta t \quad \text{---- (1)}$$

$$u_{t+\Delta t} = u_t + \dot{u}_{t+\Delta t} + \left\{\left(\tfrac{1}{2}-\alpha\right)\ddot{u}_t + \alpha \ddot{u}_{t+\Delta t}\right\}\Delta t^2 \quad \text{---(2)}$$

Newmark proposed an unconditionally-stable scheme

✓ Av. acc. method ⇒ Klaus Jurgen Bathe and Edward L Wilson. 1987. Numerical methods in finite element analysis. Prentice-Hall India (P) Ltd pp 524.

$\alpha = 0.25$ $\delta = 0.5$, $\Delta t$ is the time step (discrete points @ this is valid

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Scheme

I Initial conditions

1) Form [K], [M] & [C]

2) Initialize $U_0$, $\dot{U}_0$ Compute $\ddot{U}_0$

3) select time step ($\Delta t$), parameter ($\alpha$, $\delta$) for the scheme

4) compute Integration constants

$$\delta \geq 0.50$$
$$\alpha \geq 0.25 (0.5 + \delta)^2 \quad \|$$

2. Derive and explain the terms in Equation of motion of Articulated Tower
3. Derive and explain the terms in equation of motion of Tension Leg Platform
4. Highlight advantages of Triceratops as applicable to deep water structural systems
5. Derive [K] of offshore triceratops from first principles

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