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 conditionally stable when the time step used is smaller than critical value

   \[ \Delta t \leq \Delta t_c \]

   where \( \Delta t_c = \frac{T_c}{5} \] where \( T_c \) is the smallest period of the system

   \[ T_c = \text{smallest period of the system} \]

   Analogy

   1. Equation is not true (strictly) at any instant of time \( k \) but it is aimed to satisfy the equation at discrete time points within the interval of solution

   2. Variations in the (displacement, vel, acc) within each time interval are assumed

   Mathematically, following Eqn are valid

   \[ \begin{align*}
   u_{k+1} &= u_k + \left( \left( \frac{1}{2} \Delta t \right)^2 u_k + \frac{1}{2} \Delta t \dot{u}_k \right) \Delta t - (1) \\
   u_{k+1} &= u_k + \dot{u}_k \Delta t + \left( \left( \frac{1}{2} \right) \dot{u}_k + \frac{1}{2} \ddot{u}_k \right) \Delta t^2 - (2)
   \end{align*} \]

   Newmark proposed an unconditionally stable scheme

   \[ \dot{u}_{\infty} = 0.25 \delta = 0.5 \]

   \[ \text{use the time step (discrete points at } \Delta t \text{ is valid} \]

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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