SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

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DEPARTMENT OF AEROSPACEENGINEERING

19ASE306 – THEORY OF VIBRATIONS AND AEROELASTICITY

III YEAR VI SEM

UNIT IV – APPROXIMATE METHODS

TOPIC – UNDAMPED FREE VIBRATION

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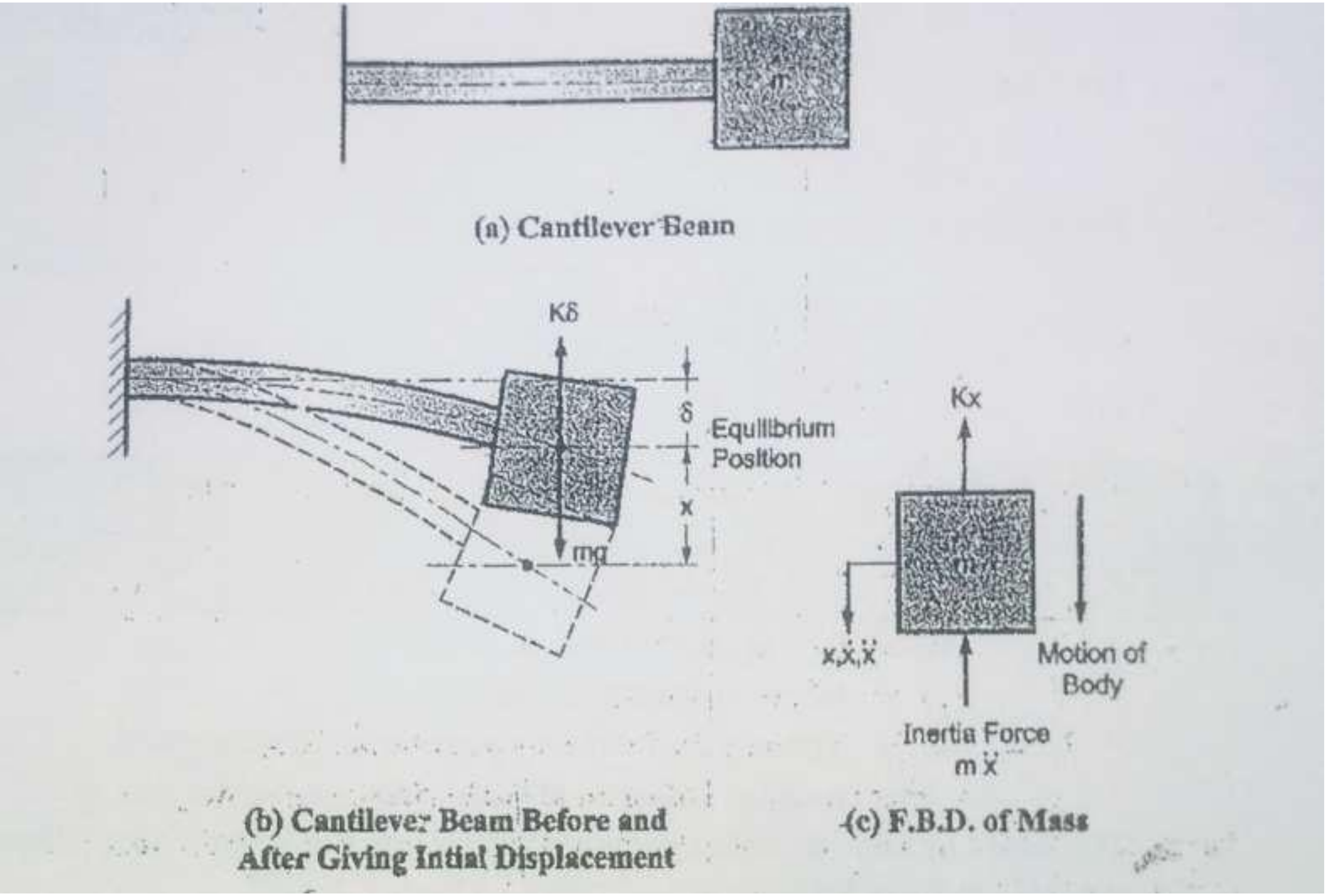
Undamped Free Transverse Vibration

- Due to gravitation force ‘mg’, the cantilever beam is deflected by ‘δ’.
- At Equilibrium position $mg = K\delta$.
- Let the system is subjected to one time external force due to which it will displaced by ‘x’ from equilibrium position.

Undamped Free Transverse Vibration



Undamped Free Transverse Vibration

- Forces acting on mass beyond mean position are,
  1. Inertia Force, $m\ddot{x}$ (upward) __________(30)
  2. Resisting Force, Kx (upward)

- According to D'amberte's principle,

$$\Sigma(\text{Inertia Force} + \text{External Force}) = 0$$

$$m\ddot{x} + Kx = 0$$

$$\ddot{x} + (K/M)x = 0 \qquad \text{\_\_\_\_\_\_(31)}$$

Undamped Free Transverse Vibration

- Comparing Eq. 31 with Eq. of S.H.M.,

$$\omega_n^2 = (K/M) \text{ rad/s}$$

$$\omega_n = \sqrt{(K/M)} \text{ rad/s} \quad \text{or } f = \tfrac{1}{2\Pi} \sqrt{(K/m)} \text{ Hz}$$

- From Eq. 30,

$$(K/M) = (g/\delta)$$

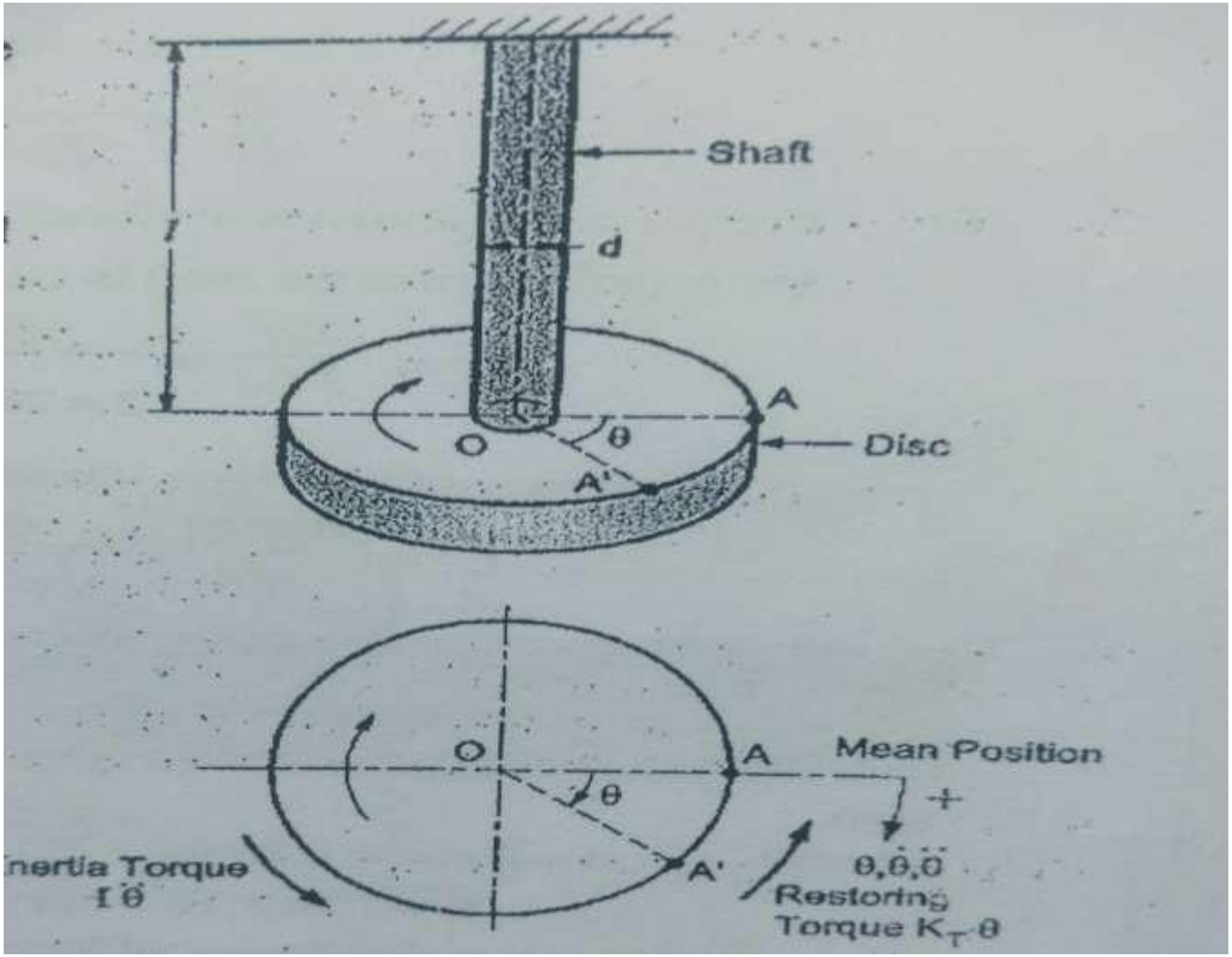
- Substituting above values,

$$F_n = (0.4985/\sqrt{\delta}) \text{ Hz}$$

Undamped Free Transverse Vibration

- Consider a disc having mass moment of inertia ‘I’ suspended on shaft with negligible mass, as shown in fig.
- If the disc is given a angular displacement about a axis of shaft, it oscillates about that axis, such vibrations are known as Torsional vibrations.

Undamped Free Torsional Vibration



Undamped Free Transverse Vibration

- For angular displacement of disc 'ϴ' in clockwise direction, the torques acting on the disc are:
- According to D'amberte's principle,

Σ(Inertia Force + External Force) = 0 I

$\theta'' + Kt.\,\theta = 0$

$$\theta'' + (Kt/I).\theta = 0 \qquad \_\_\_\_\_\_\_(32)$$

Undamped Free Torsional Vibration

- The fundamental Eq. of S.H.M.
  $\Theta'' + \omega n\, \Theta = 0$

  ______(33)

- By Comparison of above Eq. 32 & 33

$$\omega n = \sqrt{(Kt/I)}\ \text{rad/s} \qquad \text{\_\_\_\_\_\_(34)}$$

$$f = ½\prod\ \sqrt{(Kt/I)}\ \ \text{Hz} \qquad \text{\_\_\_\_\_\_(35)}$$

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THANK YOU