Adda247

WELCOME

TO Adda247

Belief creates the actual fact


Download Now
Adda247 APP
APP FEATURES
Premium Study Material
Current Affairs
Job Alerts
Daily Quizzes
Subject-wise Quizzes
Magazines
Power Capsule
Notes & Articles
Videos


ENGINEERS
SUBSCRIBE NOW
Engineers Adda247
YouTube Channel

Control system

unit step response order-2 system

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$R(s) \rightarrow \frac{1}{s}$ $\quad r(t) \rightarrow u(t)$

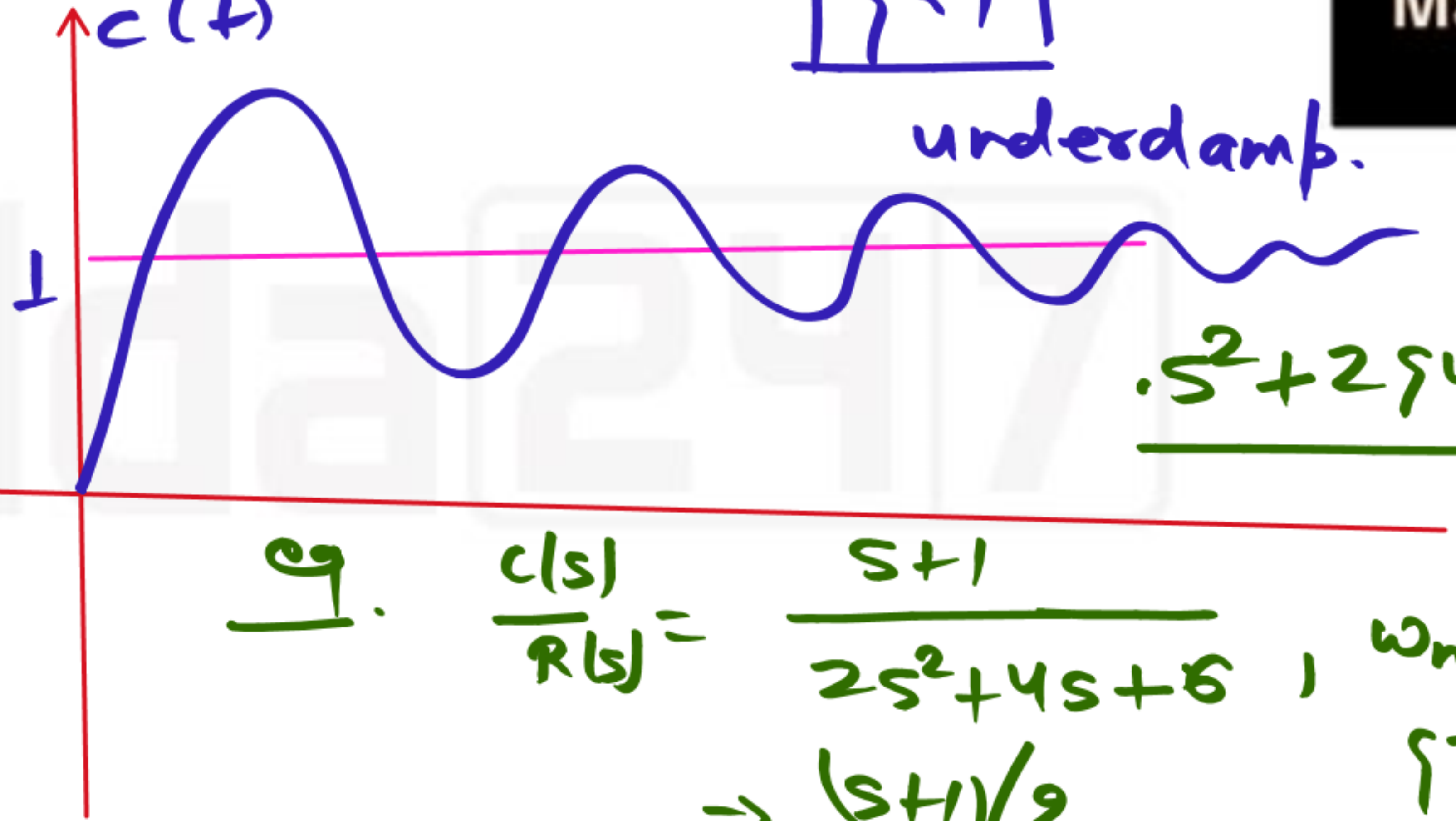
$\theta = \tan^{-1} \frac{\sqrt{1-\zeta^2}}{\zeta}$

$\cos\theta = \zeta$

$$c(t) = 1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{1-\zeta^2}} \sin(\omega_d t + \theta).$$

$\omega_d = \omega_n\sqrt{1-\zeta^2}$

$$c(t) = 1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{1-\zeta^2}} \sin(\omega_d t + \theta).$$



$\zeta < 1$ underdamp.

$\zeta\omega_n \rightarrow$ damping factor.

$\zeta = \frac{\zeta\omega_n}{\omega_n} \rightarrow$ damping ratio.

$\omega_n \rightarrow$ natural freq

$\omega_d = \omega_n\sqrt{1-\zeta^2} \rightarrow$ damped freq.

$s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$

eg. $\frac{C(s)}{R(s)} = \frac{s+1}{2s^2+4s+6}$, $\omega_n = ?$ $\zeta = ?$

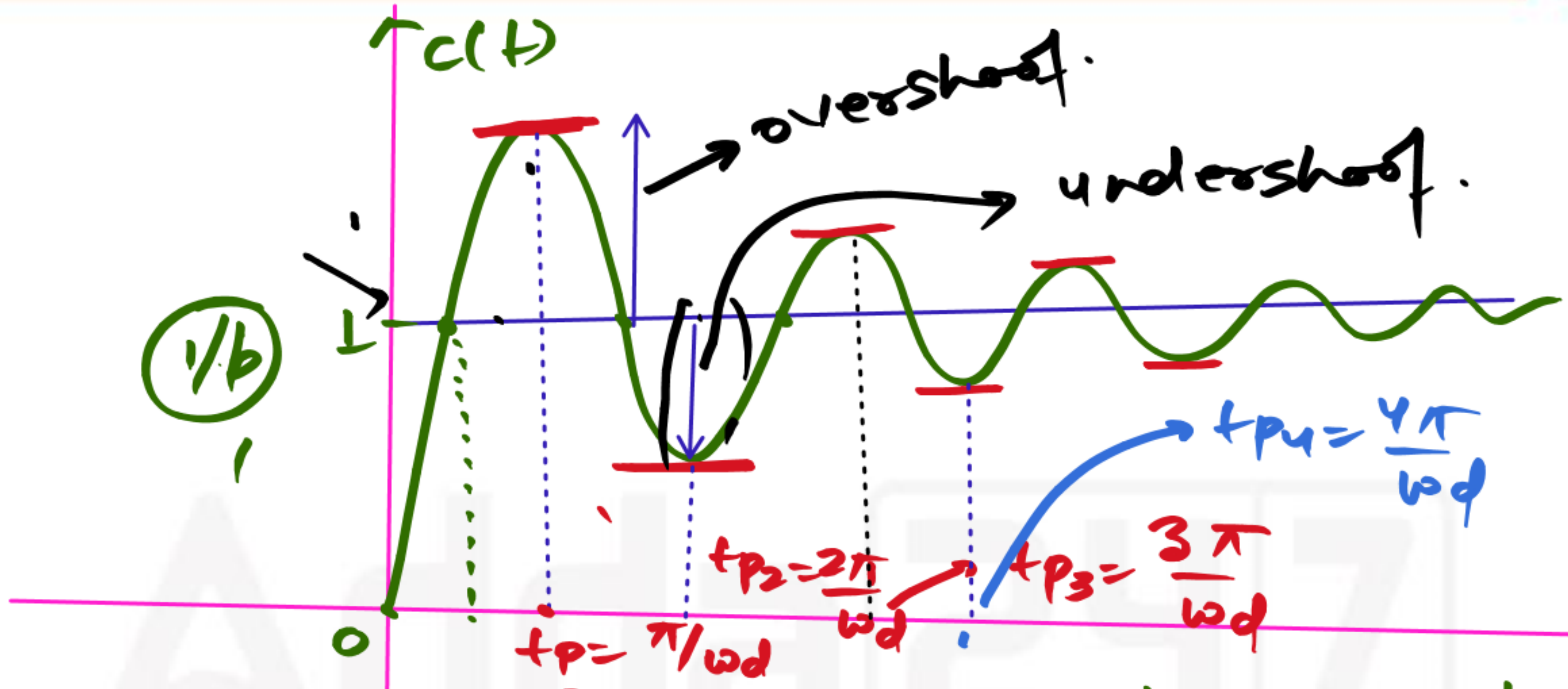
$\rightarrow \frac{(s+1)/2}{s^2+2s+3}$

$s^2+2s+3=0$ $\quad$ $s^2+2\zeta\omega_n s+\omega_n^2 = 0$

$\Rightarrow \omega_n = \sqrt{3}$ rad/s

$2\times\zeta\times\omega_n = 2$

$\zeta = \frac{1}{\omega_n} = \frac{1}{\sqrt{3}}$



2. Peak time

$$t_{p_n} = \frac{n\pi}{\omega_d} = \frac{n\pi}{\omega_n\sqrt{1-\zeta^2}}$$

$$\rightarrow t_{p_n} = \frac{n\pi}{\omega_d}$$

$n \rightarrow$ odd $\rightarrow$ overshoot

$n \rightarrow$ even $\rightarrow$ undershoot

1. Rise time

$$\theta = \cos^{-1}(\zeta)$$

$t_r \rightarrow$ 0 – 100 %

Underdamp.

$$t_r = \frac{\pi - \theta}{\omega_d} = \frac{\pi - \theta}{\omega_n\sqrt{1-\zeta^2}}$$

* Maximum overshoot

$$= \frac{c(t)_{max} - c(t)_{des.}}{c(t)_{des.}} \times 100$$

n → 1 → M.O

n → 2 → M.U

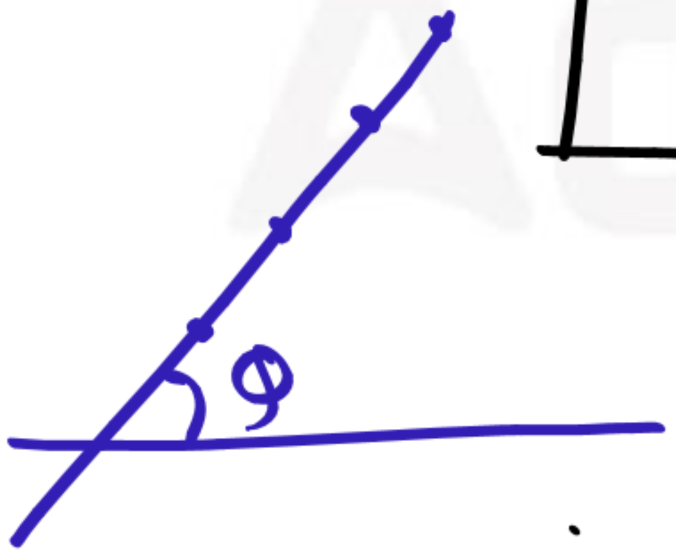
$$= e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100$$

n → odd → overshoot.

In gen.: → M.O/M.U = $e^{\frac{-n\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100$

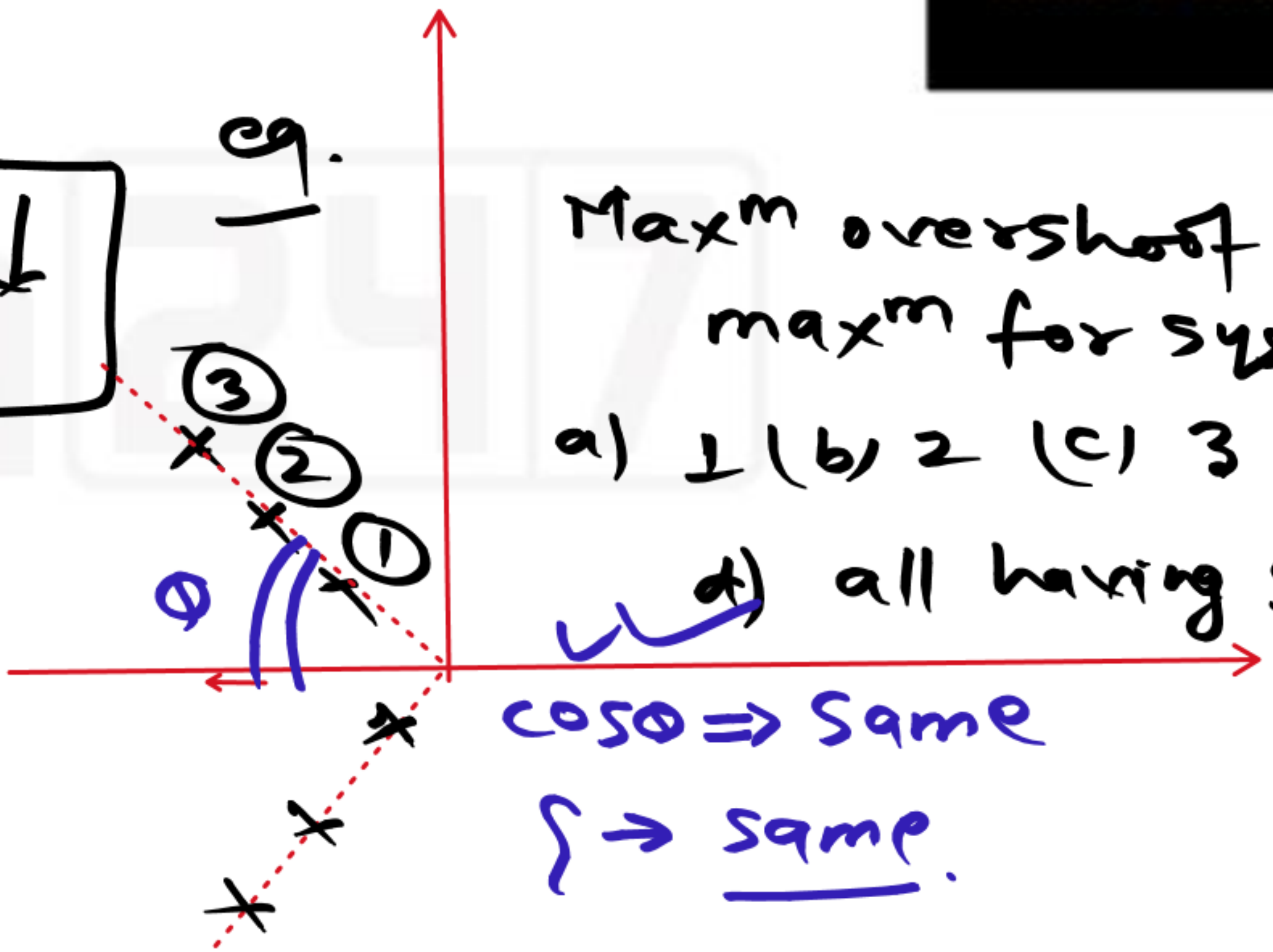
n → even → undershoot.

* Max^m overshoot/undershoot depends only upon ξ.



$\xi \uparrow$	M.O $\downarrow$

eg.



Max^m overshoot is max^m for system

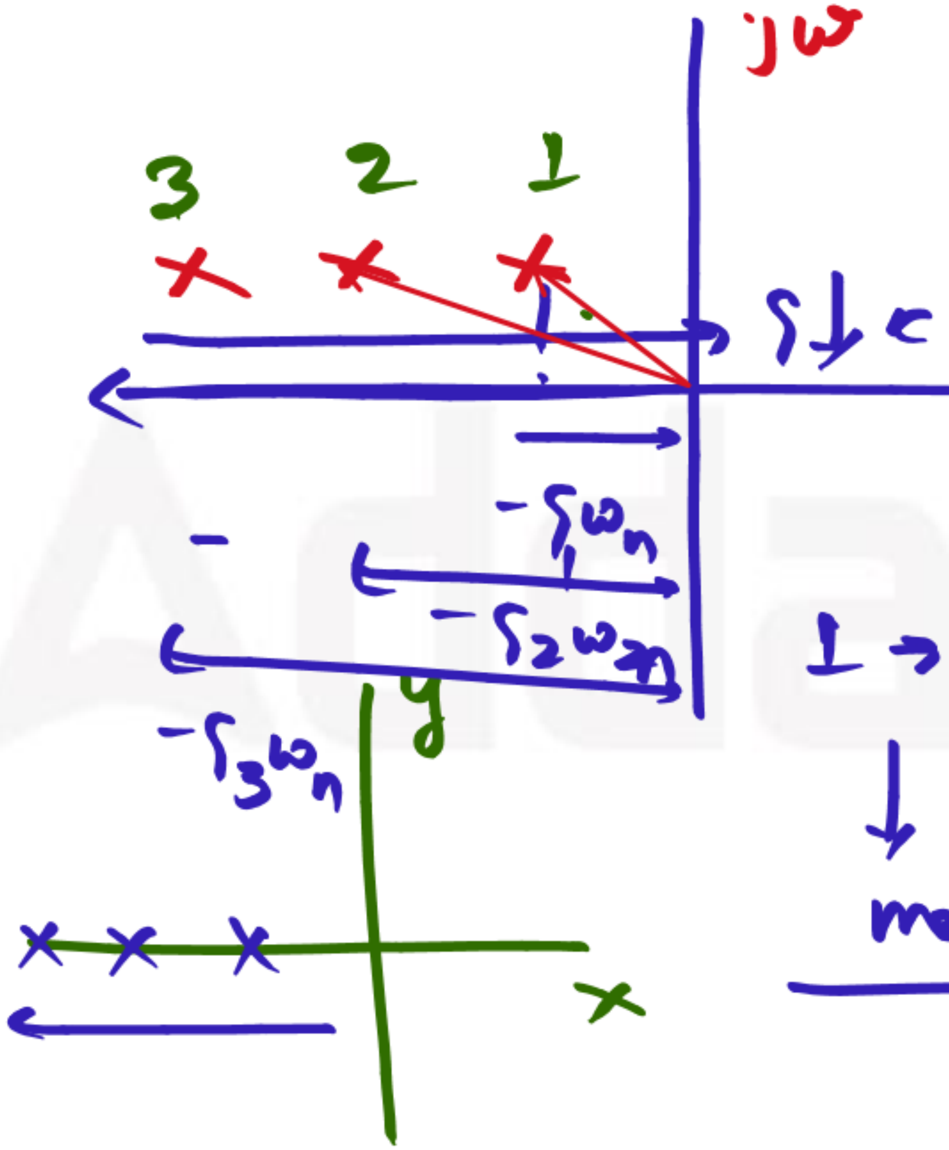
a) 1 (b) 2 (c) 3

d) all having same ✓

$\cos\theta \Rightarrow$ same

$\xi \rightarrow$ same.

eg.



$\omega_n \rightarrow$ const

1 → max^m overshoot

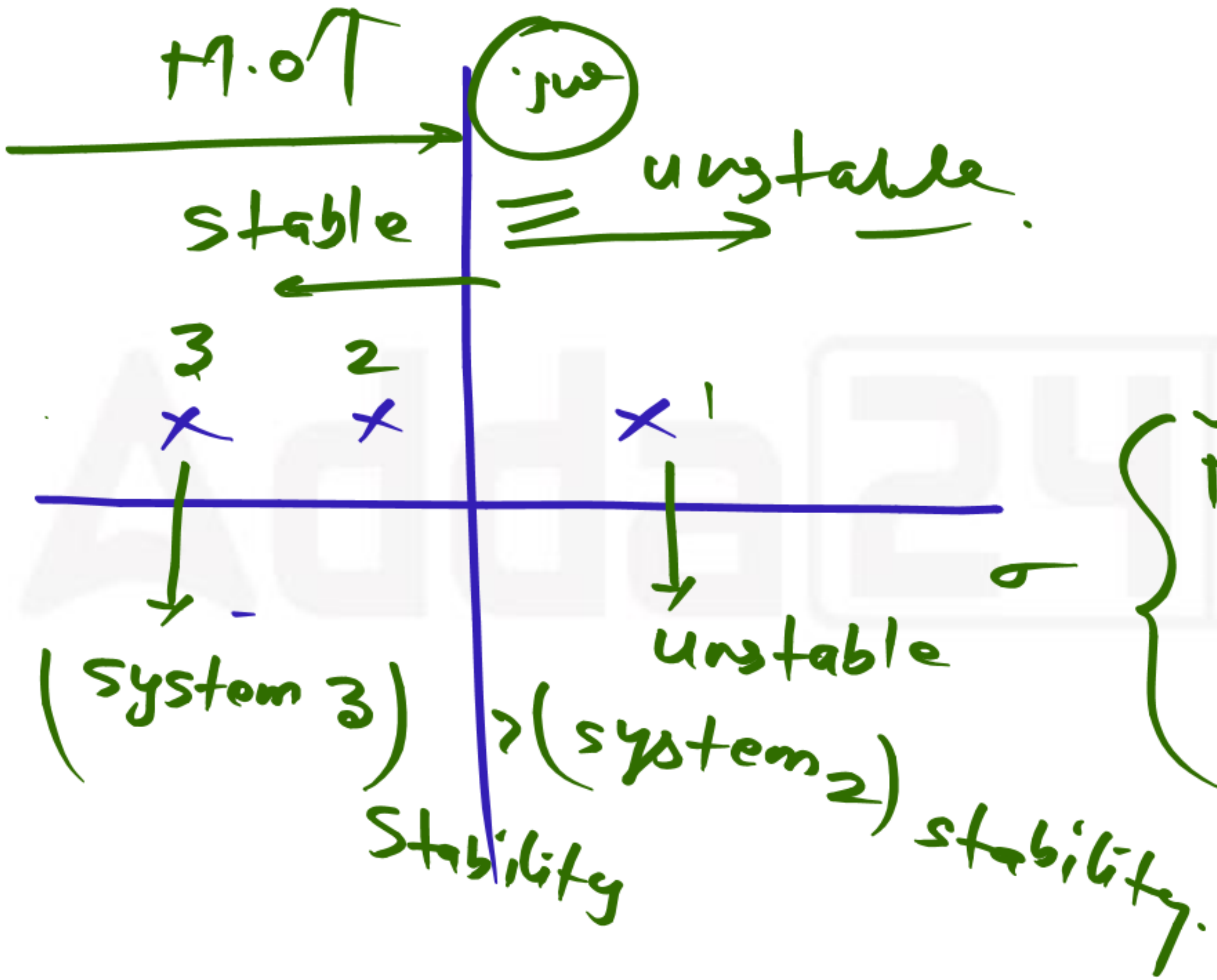
↓

max

M.O depends only upon ζ.

$\zeta \downarrow$ M.O $\uparrow$

$\zeta \uparrow$ M.O $\downarrow$



M.O defines relative stability.

M.O↑ relative stability↓

THANKS FOR

Watching

Adda247

LIKE

SHARE

COMMENT

SUBSCRIBE