

EE2227 PRESENTATION-1

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EE18BTECH11012

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Content

- 2018 GATE paper(EE section)
- Question No:9

Question

Match the transfer functions of the second-order systems with the nature of the systems given below

Transfer functions

$$P : \frac{15}{s^2 + 5s + 15}$$

$$Q : \frac{25}{s^2 + 10s + 25}$$

$$R : \frac{35}{s^2 + 18s + 35}$$

Systems

1:Overdamped

2:critically damped

3 : *Underdamped*

(A)P-1,Q-2,R-3

(B)P-2,Q-1,R-3

(C)P-3,Q-2,R-1

(D)P-3,Q-1,R-2

Solution

The standard transfer function $H(s) = \frac{\omega^2}{s^2 + 2\zeta\omega s + \omega^2}$

where

" ω " is natural frequency
and " ζ " is damping factor

then compare the given functions with this we get

1. For Transfer function $H(s) = \frac{15}{s^2 + 5s + 15}$,

$$\omega^2 = 15$$

$$2\zeta\omega = 5$$

$$\text{then we get } \zeta = \sqrt{\frac{5}{12}} < 1$$

Solution

2. For Transfer function $H(s) = \frac{25}{s^2 + 10s + 25}$,

$$\omega^2 = 25$$

$$2\zeta\omega = 10$$

$$\text{then we get } \zeta = \sqrt{\frac{5}{5}} = 1$$

3. For Transfer function $H(s) = \frac{35}{s^2 + 18s + 35}$,

$$\omega^2 = 35$$

$$2\zeta\omega = 18$$

$$\text{then we get } \zeta = \sqrt{\frac{81}{35}} > 1$$

Solution contd...

The damping of a system can be described as being one of the following:

Overdamped

The system returns to equilibrium without oscillating. For this $\zeta > 1$.

Critically damped

The system returns to equilibrium as quickly as possible without oscillating. For this $\zeta = 1$

Underdamped

The system oscillates (at reduced frequency compared to the undamped case) with the amplitude gradually decreasing to zero. For this $0 < \zeta < 1$

Undamped

The system oscillates at its natural resonant frequency (ω_0).
For this $\zeta = 0$

Final Analysis

- As for P: $\zeta < 1$
It is Underdamped system
- As for Q: $\zeta = 1$
It is critically damped system.
- As for R: $\zeta > 1$
It is an overdamped system.

So, P-3, Q-2, R-1. Option (C) is correct.

Graphs of transfer functions

graphicx

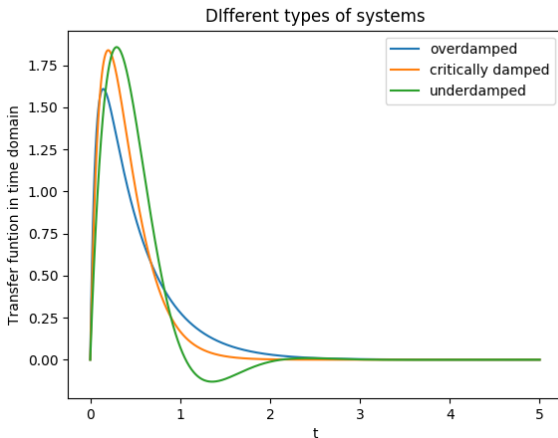


Figure: Different systems based on ζ

The End