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	Systems
P : $\frac{15}{s^2+5s+15}$	1:Overdamped
Q : $\frac{25}{s^2+10s+25}$	2:critically damped
R : $\frac{35}{s^2+18s+35}$	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 $H(s)=\frac{\omega^2}{s^2+2\zeta\omega+\omega^2}$

where

"ω" *is natural frequency*

and "ζ" *is damping factor*

then compare the given functions with this we get

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

$$\omega^2 = 15$$

$$2\zeta\omega = 5$$

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($\omega 0$).
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

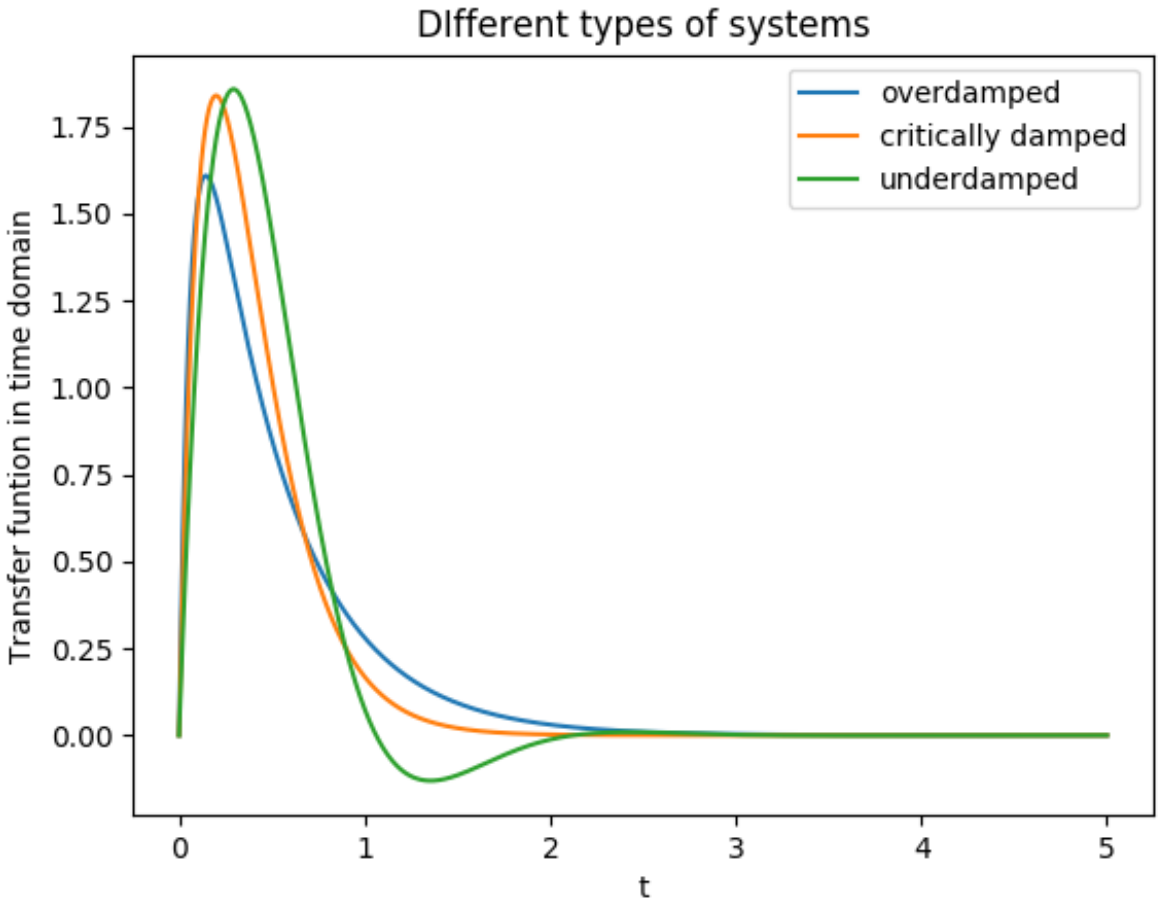

Figure: Different systems based on ζ

The End