DOS : MDOF systems

Number of participants: 15

1. The mode shapes and eigenfrequencies of a system are determined by (K and M are the stiffness and mass matrices)

11 correct answers
out of 12 respondents

	Calculating the eigenvalues of the stiffness matrix K of the system	8%	1 vote
✓	solving a generalized eigenvalue problem of the type (K-w^2M) {Phi} = 0	92%	11 votes
	Calculating the eigenvalues of the mass matrix M of the system	0%	0 votes
	Calulating w=K/M	0%	0 votes

2. If a system has n degrees of freedom, it has

12 correct answers
out of 12 respondents

	2n natural frequencies	0%	0 votes
✓	n natural frequencies	100%	12 votes
	(n + the number of excitations) natural frequencies	0%	0 votes
	it depends on the type of system	0%	0 votes

3. The mode shapes are orthogonal with respect to the

6 correct answers
out of 10 respondents

✓	stiffness matrix	100%	10 votes
✓	mass matrix	60%	6 votes
	damping matrix	0%	0 votes

4. The interest of projecting the equations of motion in the modal domain is to:

2 correct answers
out of 13 respondents

✓	potentially reduce the number of equations to solve	38%	5 votes
✓	decouple the equations of motion and facilitate solving them	77%	10 votes
	work with physical quantities for a better understanding of the system's behavior	46%	6 votes

5. Which of these quantities is a global quantity for a given structure (i.e does not change with the position where you measure the response)

5 correct answers
out of 13 respondents

✓	the eigenfrequency	69%	9 votes
	the anti-resonance frequency	23%	3 votes
✓	the damping coefficient	69%	9 votes

6. An anti-resonance happens when

12 correct answers
out of 12 respondents

	The contribution to the response of the two close modes as equal amplitude and equal phase	0%	0 votes
✓	The contribution to the response of the two close modes has equal amplitude and opposite phase	100%	12 votes
	The displacement is zero for the two closest modes	0%	0 votes

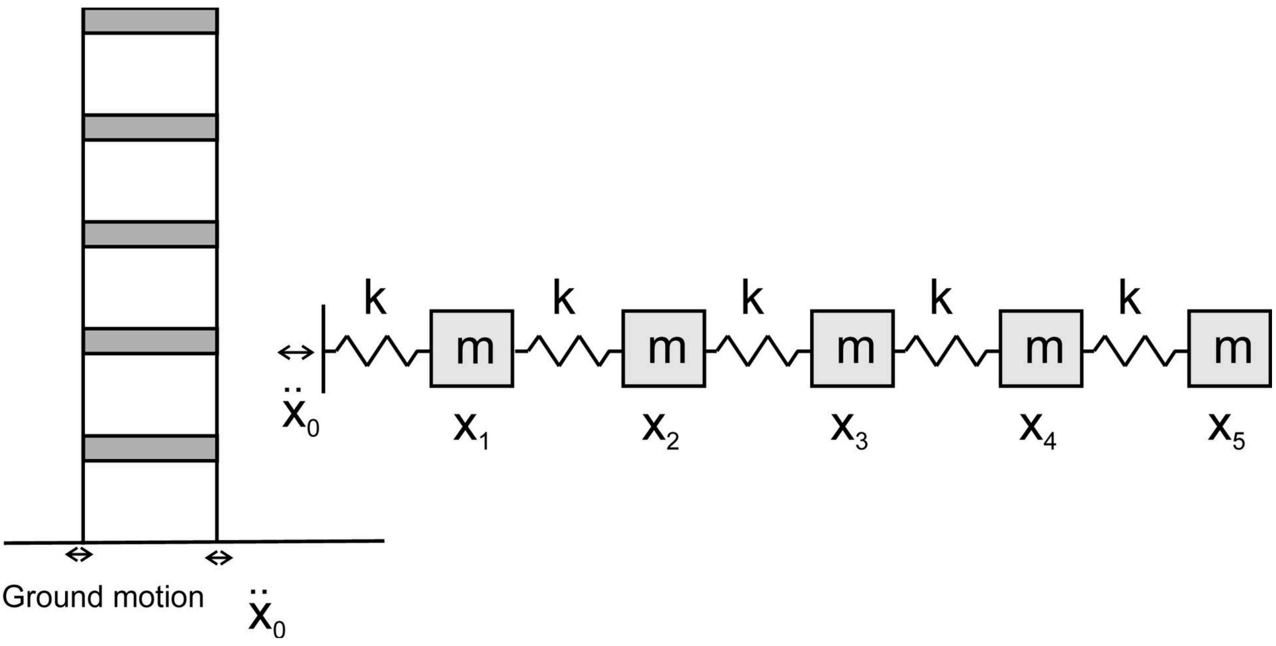
7. What kind of hypothesis can be made on the damping matrix to decouple the equations of motion in the modal domain ?

1 correct answer
out of 10 respondents

✓	Rayleigh Damping	100%	10 votes
	Lagrange Damping	0%	0 votes
✓	Modal damping	50%	5 votes
✓	Viscous damping	30%	3 votes

8. How many mode shapes and eigenfrequencies does this building simplified model have ?

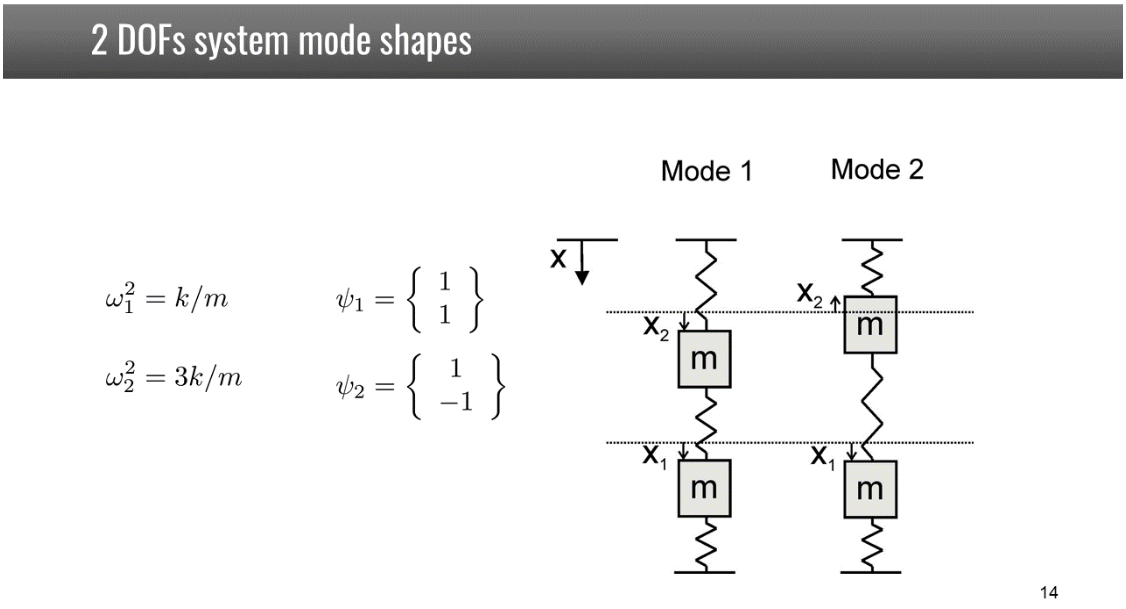
10 correct answers
out of 14 respondents



	one	0%	0 votes
	three	14%	2 votes
✓	five	71%	10 votes
	an infinity	14%	2 votes

9. If this system is excited with an harmonic force applied to the bottom mass, whose frequency is close to the first natural frequency, the motion will correspond to

10 correct answers
out of 13 respondents



2 DOFs system mode shapes

$$\omega_1^2 = k/m \qquad \psi_1 = \begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$$

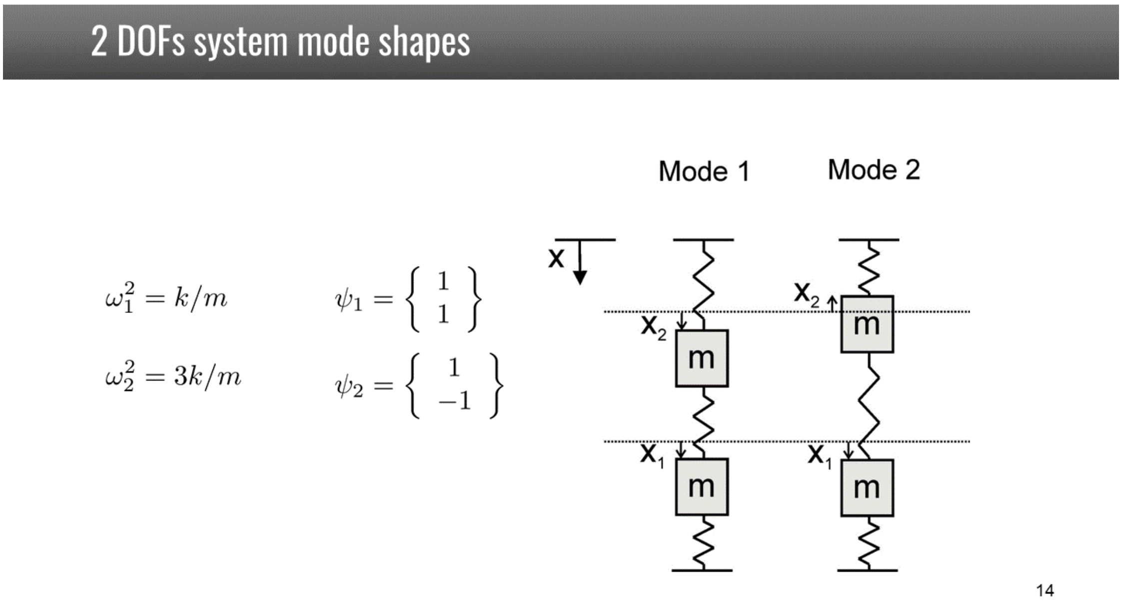
$$\omega_2^2 = 3k/m \qquad \psi_2 = \begin{Bmatrix} 1 \\ -1 \end{Bmatrix}$$

14

✓ The first mode shape where the two masses move in phase	77%	10 votes
The second mode shape where the two masses move out of phase	15%	2 votes
A combination of the two modeshapes	8%	1 vote

10. If this system is excited with an harmonic force applied to the bottom mass, whose frequency is the average of the first and second natural frequencies of the system, the motion will correspond to

8 correct answers
out of 10 respondents



2 DOFs system mode shapes

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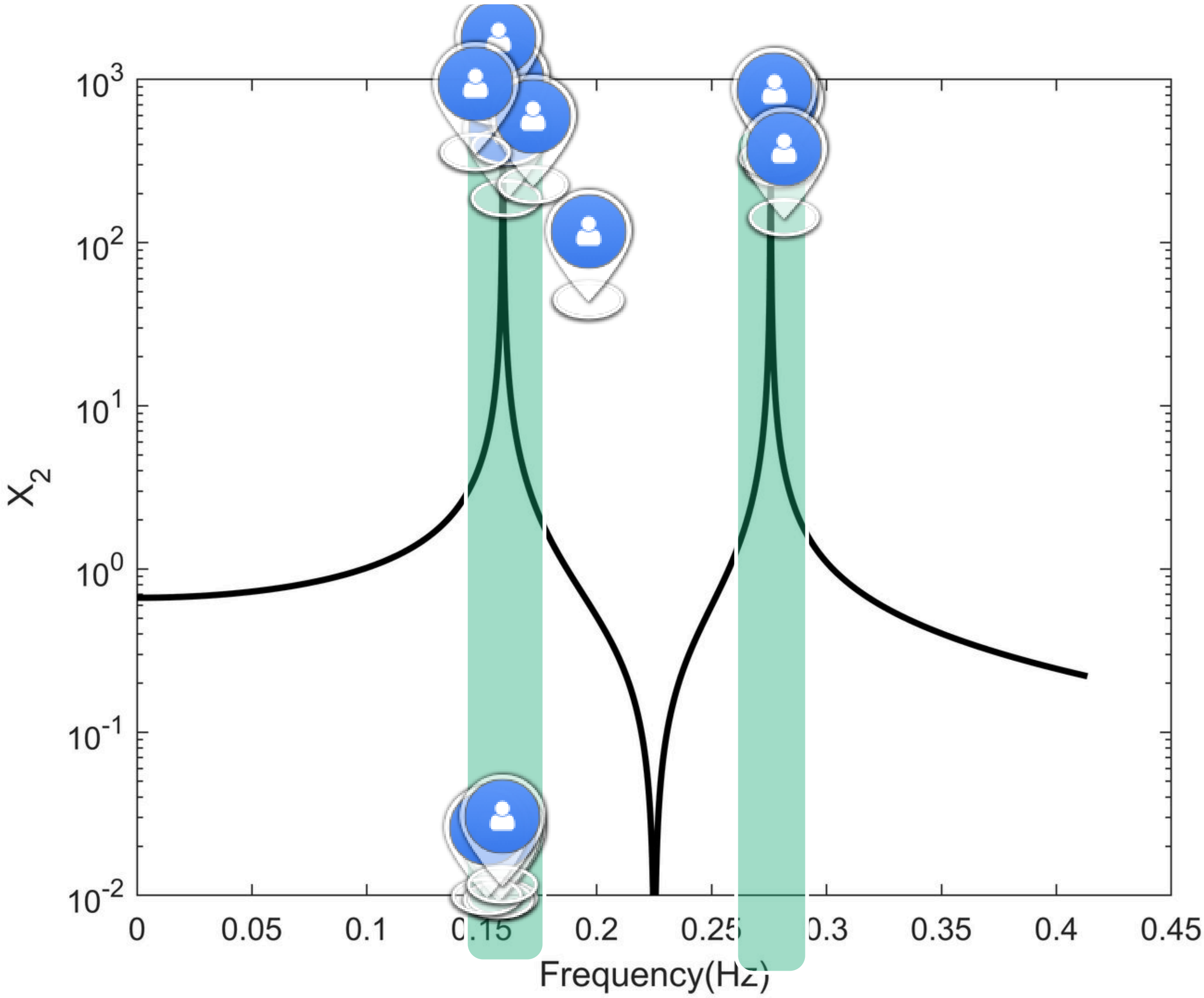
$$\omega_2^2 = 3k/m \qquad \psi_2 = \begin{Bmatrix} 1 \\ -1 \end{Bmatrix}$$

14

	The first mode shape where the two masses move in phase	0%	0 votes
	The second mode shape where the two masses move out of phase	20%	2 votes
✓	A combination of the two mode shapes	80%	8 votes

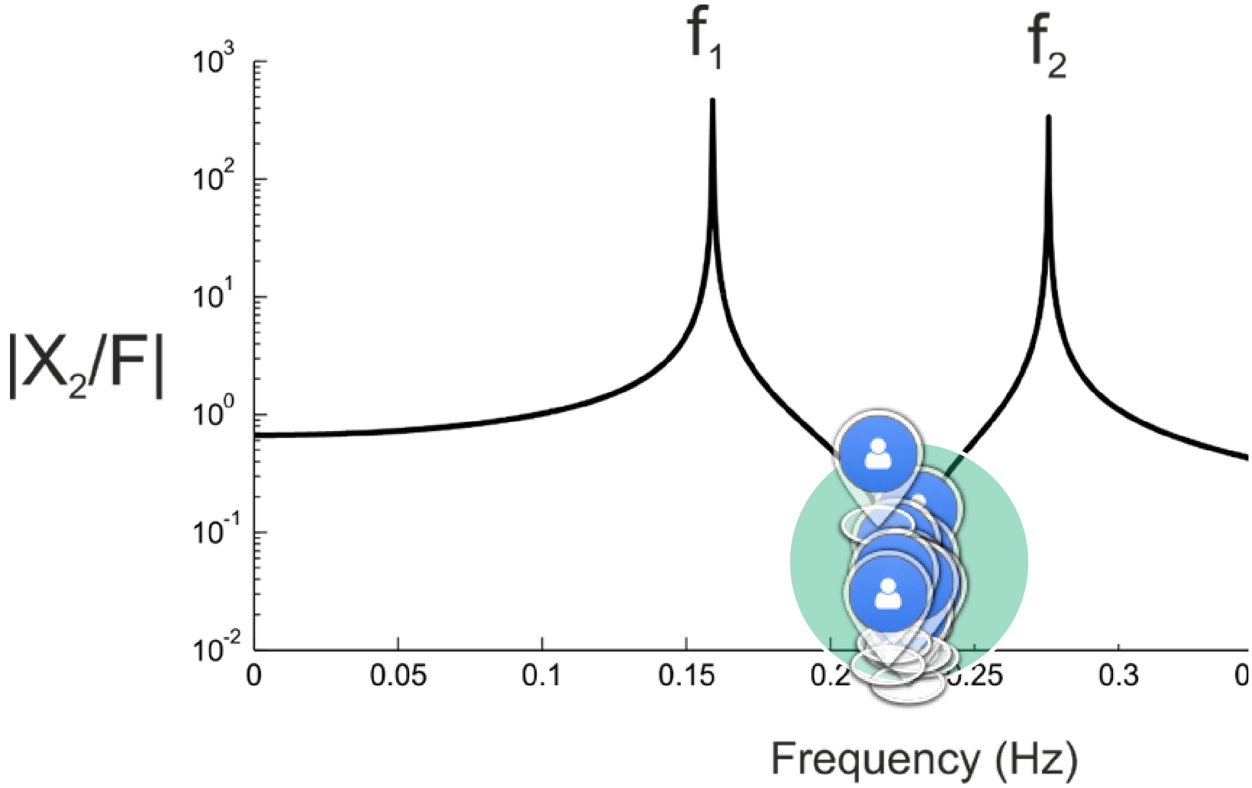
11. Where are the resonant frequencies of the 2 DOFs system on this graph ?

13 respondents



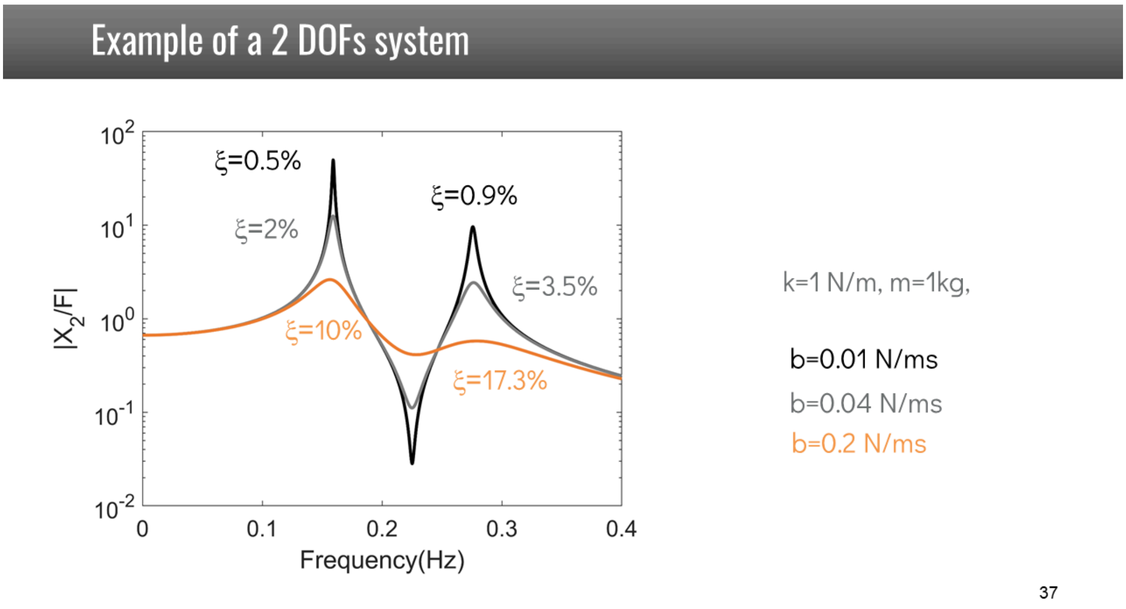
12. Where is the anti-resonance of the 2 DOFs system on this graph ?

12 respondents



13. Why is the damping coefficient higher for the second mode than for the first mode for the damped two dofs system treated in the examples of the course ?

9 respondents



Example of a 2 DOFs system

k=1 N/m, m=1kg,

b=0.01 N/ms

b=0.04 N/ms

b=0.2 N/ms

Because in the first mode the 2 mass are in phase instead in the seconde mode they are in opposition of phase

.

The damping if fonction of the frequency The movements is bigger between the two mass

Second Natural frequency higher

Eigenvalues of damping coefficient are closer to the eigenvalues of the second mode shape

Because the spring between the 2 masses is not extended

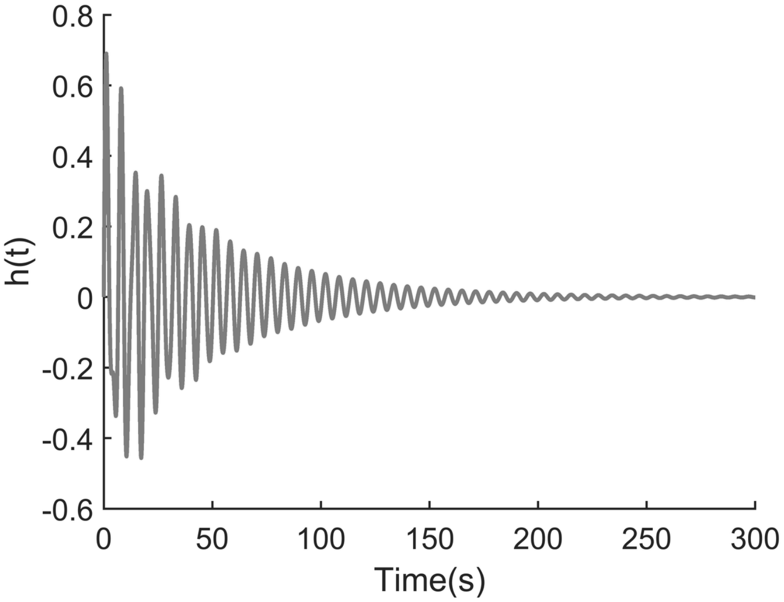
The masses go in opposite directions

It’s giroup

Because in the second mode, the middle spring dissipates energy

14. How would you extract the first natural frequency from the impulse response ?

0 correct answer
out of 5 respondents



Two first same pics at the bottom (0.4)

Fourier analysis or using the exponential function decreasing

See the frequency at steady state

Determining the exponential envelopppe after the zone of interaction

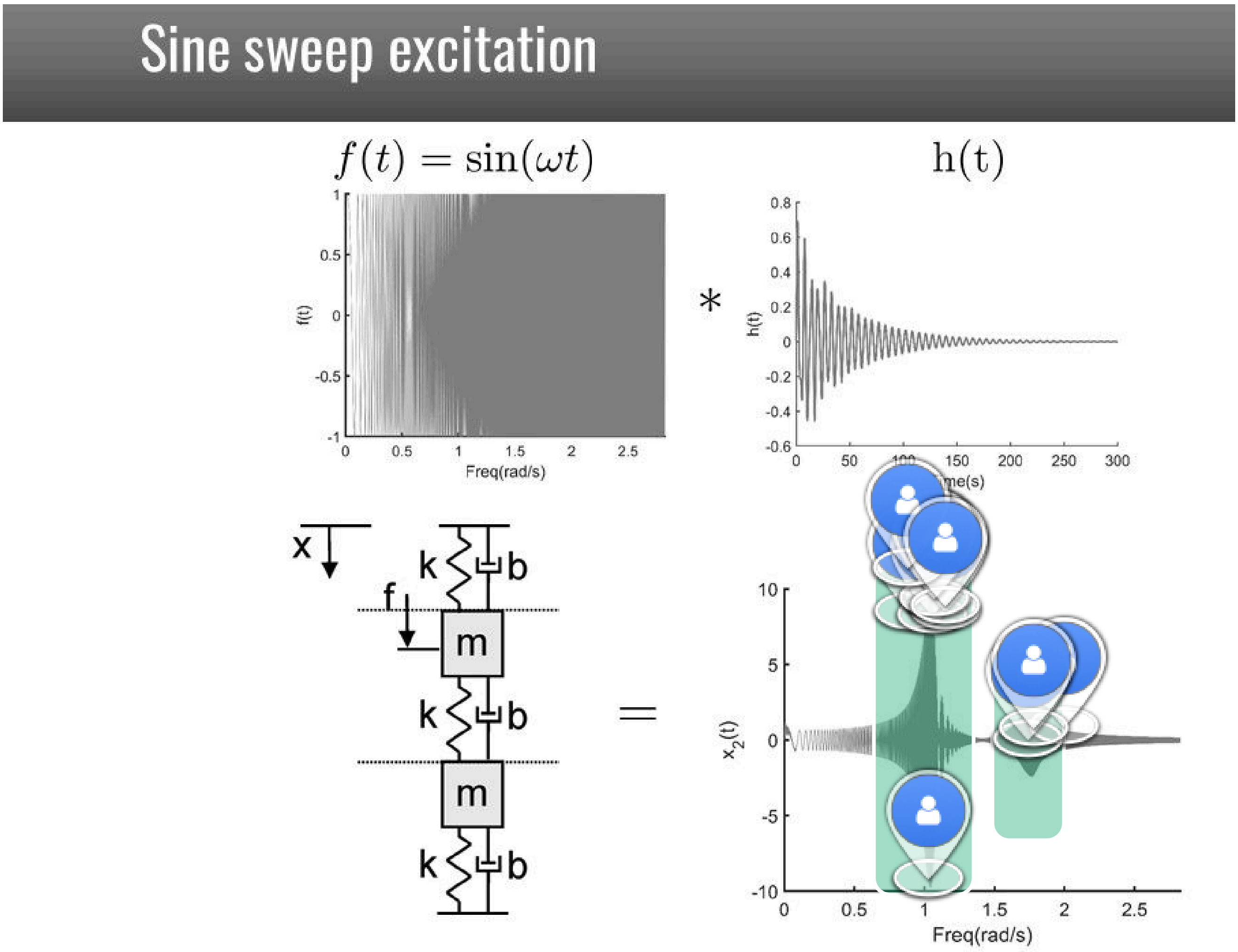
Put a low pass filter Maybe the first frequency because it is not attenuated

Correct answer

By looking at the end of the response and extracting the period from the distance between two crossings of the axis.

15. This is the time domain response of a damped 2 DOFs system under sine sweep excitation. Where do you see the resonances on the time domain response ?

11 respondents



Sine sweep excitation

16. When a system is excited by its base, it is easier to write the unknown displacements

4 correct answers
out of 8 respondents

	as relative displacement between the neighbouring DOFS	50%	4 votes
✓	as relative displacement between the base and each DOF.	50%	4 votes
	in mm instead of m	0%	0 votes

17. When doing so, the equation of motion is equivalent to the case of an applied force which is

5 correct answers
out of 8 respondents

✓	proportional to the applied acceleration	63%	5 votes
	inversely proportional to the applied acceleration	25%	2 votes
	proportional to the applied displacement	13%	1 vote