VIB : Equivalent SDOF system

Number of participants: 27

1. A complex structure can be represented by an equivalent SDOF using

2 correct answers
out of 23 respondents

✓	the principles of equivalent mass and spring if the structure is made of a large rigid mass attached to a reference with a flexible element	83%	19 votes
✓	a single mode approximation if the eigenfrequencies are well separated	17%	4 votes
	A division of the structure using single finite elements	30%	7 votes

2. In the case of a rigid mass with a flexible element, In order to compute an equivalent stiffness, one needs to

11 correct answers
out of 16 respondents

✓	Apply a static force at the location where the mass is attached and in the direction of the motion of the mass	69%	11 votes
	Apply an harmonic force at the location where the mass is attached and in the direction of the motion of the mass	31%	5 votes
	Compute the first 5 modes shapes of the flexible element	0%	0 votes

3. The equivalent stiffness is then given by

19 correct answers
out of 22 respondents

✓	k=F/x where x is the displacement in the direction of motion at the location of the applied force	86%	19 votes
	k=F/x where x is the average displacement computed on the flexible element	9%	2 votes
	k= F*x where x is the displacement in the direction of motion at the location of the applied force	5%	1 vote

4. For a bar in traction with section A, young's modulus E and length L, the equivalent stiffness is given by

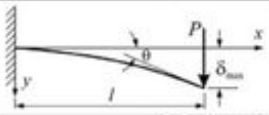
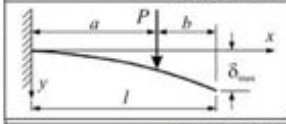
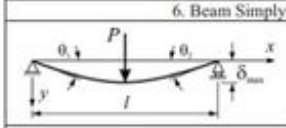
17 correct answers
out of 21 respondents

	k = E A L	5%	1 vote
✓	k=EA/L	81%	17 votes
	k=E/(A*L)	14%	3 votes
	k=1/(EAL)	0%	0 votes

5. Consider a cantilever beam with a mass attached at the tip. If the length of the beam is doubled, the first natural frequency is

6 correct answers
out of 15 respondents

BEAM DEFLECTION FORMULAE

BEAM TYPE	SLOPE AT FREE END	DEFLECTION AT ANY SECTION IN TERMS OF x	MAXIMUM DEFLECTION
1. Cantilever Beam – Concentrated load P at the free end			
	$\theta = \frac{Pl^2}{2EI}$	$y = \frac{Px^2}{6EI}(3l - x)$	$\delta_{max} = \frac{Pl^3}{3EI}$
2. Cantilever Beam – Concentrated load P at any point			
	$\theta = \frac{Pa^2}{2EI}$	$y = \frac{Px^2}{6EI}(3a - x)$ for $0 < x < a$ $y = \frac{Pa^2}{6EI}(3x - a)$ for $a < x < l$	$\delta_{max} = \frac{Pa^2}{6EI}(3l - a)$
6. Beam Simply Supported at Ends – Concentrated load P at the center			
	$\theta_1 = \theta_2 = \frac{Pl^2}{16EI}$	$y = \frac{Px}{12EI}\left(\frac{3l^2}{4} - x^2\right)$ for $0 < x < \frac{l}{2}$	$\delta_{max} = \frac{Pl^3}{48EI}$

multiplied by 2	13%		2 votes
divided by 2	27%		4 votes
✓ divided by 2 sqrt(2)	40%		6 votes
divided by 4	20%		3 votes

6. To compute the equivalent mass of a flexible element simplified by a spring element, one needs to

15 correct answers
out of 18 respondents

use the principle of d'Alembert	11%	2 votes
compute the total mass of the flexible element and divided it by 3	6%	1 vote
✓ equate the kinetic energy of the flexible element with the one of the additional mass located at the tip of the spring	83%	15 votes

7. When replacing a flexible element by a spring, the approximation is

12 correct answers
out of 18 respondents

always valid	6%	1 vote
valid only above the first natural frequency of the flexible element	28%	5 votes
✓ valid in a limited frequency band where the element's natural frequencies are not excited	67%	12 votes

8. When using single mode approximation, the equivalent mass and stiffness of the SDOF system depend on

3 correct answers
out of 14 respondents

✓	The value of the eigenfrequency of the mode	29%	4 votes
	The average value of the modeshape considered	7%	1 vote
✓	The value of the modeshape considered at the position and in the direction of the applied force	100%	14 votes

9. Consider the wing of an aircraft, which method is most suited to reduce it to an equivalent SDOF system ?

3 correct answers
out of 19 respondents

	The equivalent mass and stiffness approach using static computation and equivalence of kinetic energy	68%	13 votes
	The single mode approximation	16%	3 votes
✓	It depends on the type of aircraft considered	16%	3 votes

10. What are the necessary assumptions to model a car as a SDOF mass-spring-damper system ?

0 correct answer
out of 10 respondents

- Concentration of mass
- The equivalent stiffness and mass
- Single degree of freedom, the vertical motion only
- equivalent stiffness and mass approach
- Model tire using a spring
- The upper part is rigid + flexible suspensions(spring)
- Small displacements
- Motion in only one direction (1D)
- No variation of mass
- Finite elements

Correct answer

The body and the wheels needs to be considered as rigid, and the motion restricted to vertical displacement.

11. What type of model would you use to model the dynamic response of a wind turbine ?

0 correct answer
out of 7 respondents

- SDOF system model
- Mass(top) + spring(column)/ also as bar with mass on top
- Finite Element model
- Mass +2 springs (vertical & horizontal)
- Beam and mass at the top
- Finite element model
- Continuous model

Correct answer

You can use a cantilever beam, but you should consider the mass at the tip, so a beam finite element model is probably the best option.