Semaine 7
QCMs

ME-332 – Mécanique Vibratoire

Prof. Guillermo Villanueva

École
polytechnique
fédérale
de Lausanne

Before we start… let's connect!

- Smartphones
  - iPhone
  - Android

  } Download and install the app "*PointSolutions*"

pointsolutions
powered by echo360

- Computers (or Windows Phones)
  - Go to www.responseware.eu

- Choose **EUROPE Server** (if asked)
- Join session – **ME332**
- When asked – **do not input your name. Enter as anonymous.**

Plan du cours

Week	Jours	Partie du cours	Exercices	Homework
1	09.09//11.09	Intro et oscillateur 1D libre conservatif	Série 1	Leçon 1.1&1.2
2	18.09	Oscillateur 1D libre dissipatif	Série 2	Leçon 2.1&2.2
3	23.09//25.09	Régime permanent harmonique (complexe)	Série 3	Leçon 3.1&3.2
4	30.09//02.10	Régime permanent périodique (série de Fourier)	Série 4	Leçon 4.1&4.2
5	07.10//09.10	Régime forcé général (transf. Laplace ou Fourier)	Série 5	Leçon 5.1&5.2
6	14.10//16.10	Systèmes à 2 DDL conservatifs	Série 6	Leçon 6.1&6.2
BREAK!!!				
7	28.10//30.10	Récapitulatif // séance de QCMs	MIDTERM	
8	04.11//06.11	Systèmes à 2DDL dissipatifs, osc. de Frahm	Série 7	Leçon 7.1&7.2
9	11.11//13.11	Systèmes à n DDL, conservatif	Série 8a	Leçon 8.1&8.2
10	18.11//20.11	Systèmes à n DDL, conservatif	Série 8b	
11	25.11//27.11	Systèmes à n DDL, dissipatif	Série 9	Leçon 9.1&9.2
12	02.12//04.12	Systèmes à n DDL, forcé	Série 10	Leçon 10.1&10.2
13	09.12//11.12	Systèmes continus: barres & poutres	Série 11	Leçon 11.1&11.2
14	16.12//18.12	Récapitulatif // séance de QCMs		

MidTerm Exam

- Date: 30 Octobre (2024)
- Heure: 13h30 – 15h00 (1h30)
  - Doors open at 13h20
- Salles: PO-01, SG 0211, AAC 1 37
- Contenu: Semaines 1-6
- Formulaire:
  - Une page A4 «recto»
    - Imprimer le formulaire dans Moodle
    - Annoter, préparer le votre, à la main, numérique...
- Pas oublier:
  - Stylo (Ni rouge ni vert)
  - Calculatrice (standard – pas pour matrices)
  - EPFL ID – Camipro

- Exam:
  - 1 question courte
  - 2 problèmes
- 30% de la note finale
- SAC dit:
  - Obligatoire et présentiel
- Séance de «révision»:
  - Lundi 28 Octobre à 8h15
  - CE 1 2

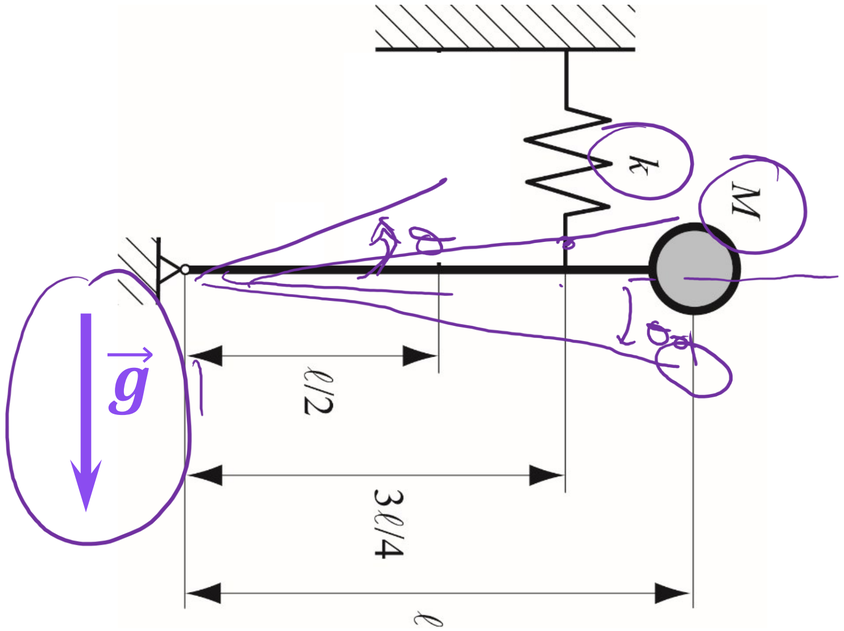
Fréquence ω_0?

A. $\omega_0 = \sqrt{k/M}$

B. $\omega_0 = 3/4\sqrt{k/M}$

C. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} + g/L}$

D. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} - g/L}$



$T = \frac{1}{2} m |v|^2 = \frac{1}{2} m (L\dot{\theta})^2 = \frac{1}{2}(mL^2)\cdot\dot{\theta}^2$

$V = mgL\cdot\sin(\theta_0+\theta) + \frac{1}{2}k\cdot\left(\frac{3}{4}L\sin(\theta-\theta_0)\right)^2$

$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{\theta}}\right) + \frac{\partial V}{\partial \theta} = 0$

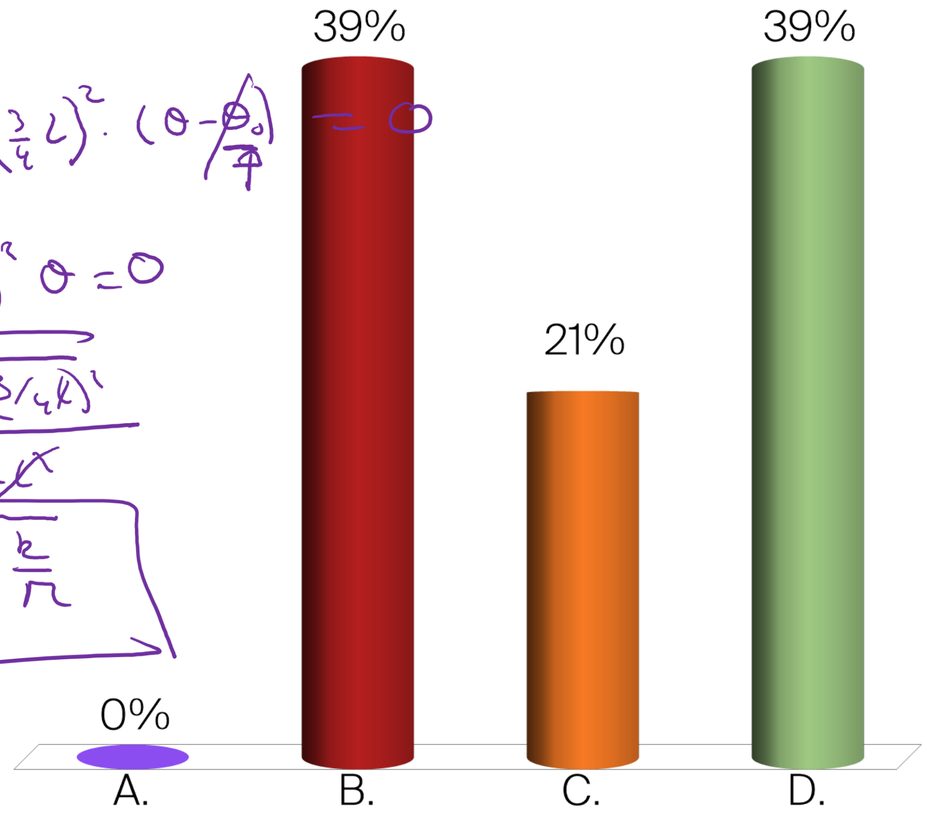
$mL^2\ddot{\theta} + mgL + k\left(\frac{3}{4}L\right)^2\cdot(\theta-\theta_0) = 0$

$mL^2\ddot{\theta} + k\left(\frac{3}{4}L\right)^2\theta = 0$

$\omega_0^2 = \frac{k\cdot(3/4)^2}{mL^2}$

ref.

$\omega_0 = \frac{3}{4}\sqrt{\frac{k}{m}}$



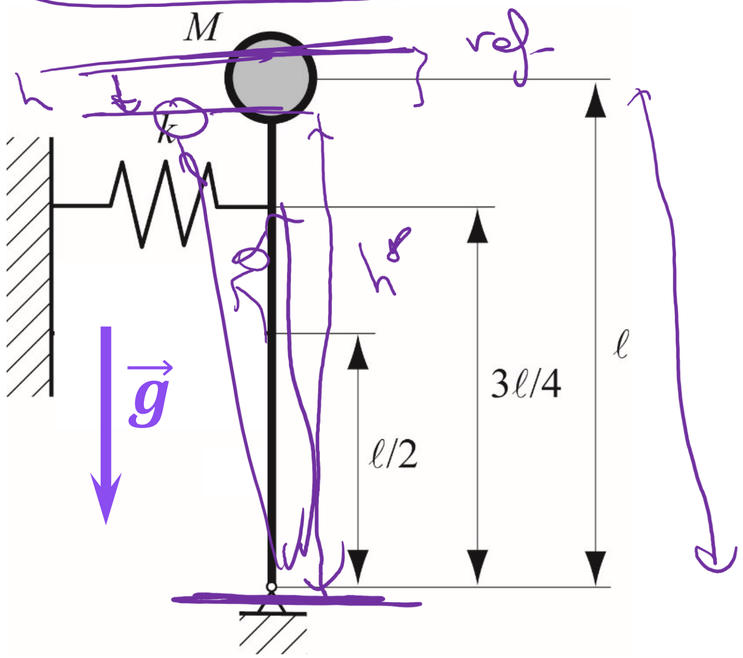
Fréquence ω_0?

A. $\omega_0 = \sqrt{k/M}$

B. $\omega_0 = 3/4\sqrt{k/M}$

C. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} + g/L}$

D. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} - g/L}$



$T = \frac{1}{2} m L^2 \dot{\theta}^2$

$V = \frac{1}{2} k \left(\frac{3}{4} L \theta\right)^2 + mg\left(L - L\left(1 - \frac{\theta^2}{2}\right)\right) = mgL\frac{\theta^2}{2}$

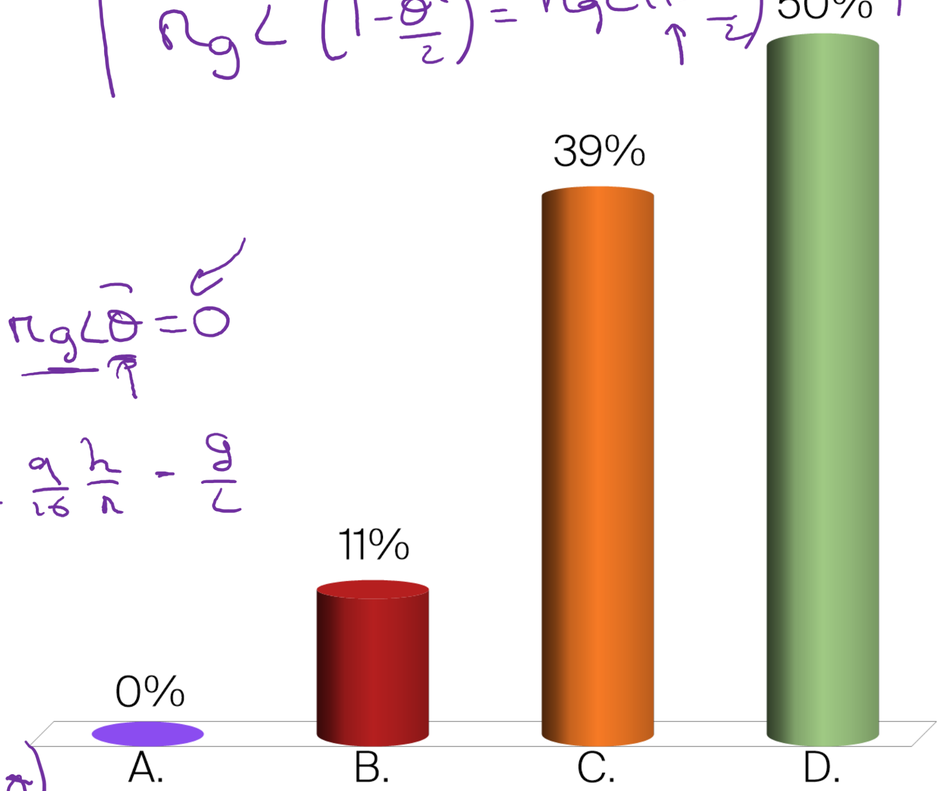
$mgL\left(1 - \frac{\theta^2}{2}\right) = mgL\left(1 - \frac{\theta^2}{2}\right)$ ↑

$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{\theta}}\right) + \frac{\partial V}{\partial \theta} = 0$

$mL^2\ddot{\theta} + k\left(\frac{3}{4}L\right)^2\theta - mgL\theta = 0$

$\omega_0^2 = \frac{\frac{9}{16}kL^2 - mgL}{mL^2} = \frac{9}{16}\frac{k}{m} - \frac{g}{L}$

$mL^2\ddot{\theta} = \sum \bar{M} = -k\left(\frac{3}{4}L\theta\right) \times \frac{3}{4}L + mgL\theta$



Fréquence ω_0?

A. $\omega_0 = \sqrt{k/M}$

B. $\omega_0 = 3/4\sqrt{k/M}$

C. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} + g/L}$

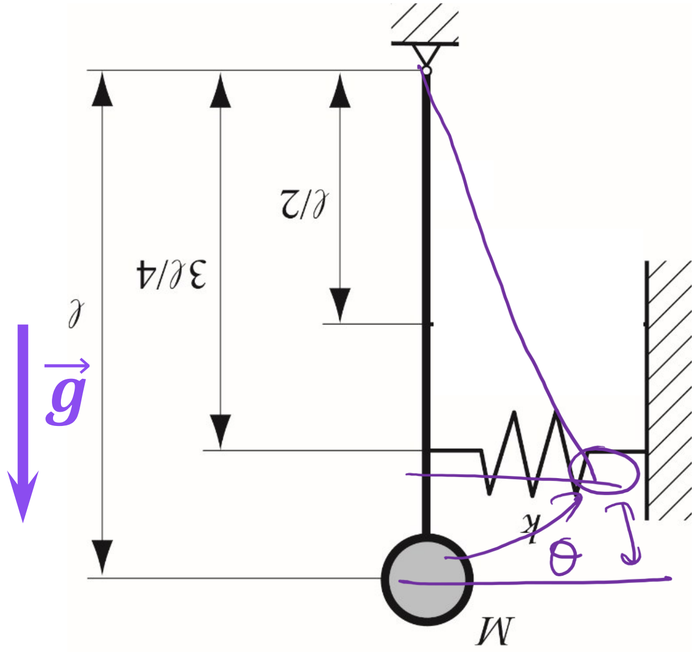
D. $\omega_0 = \sqrt{{}^{9}/_{16}\,{}^{k}/_{M} - g/L}$

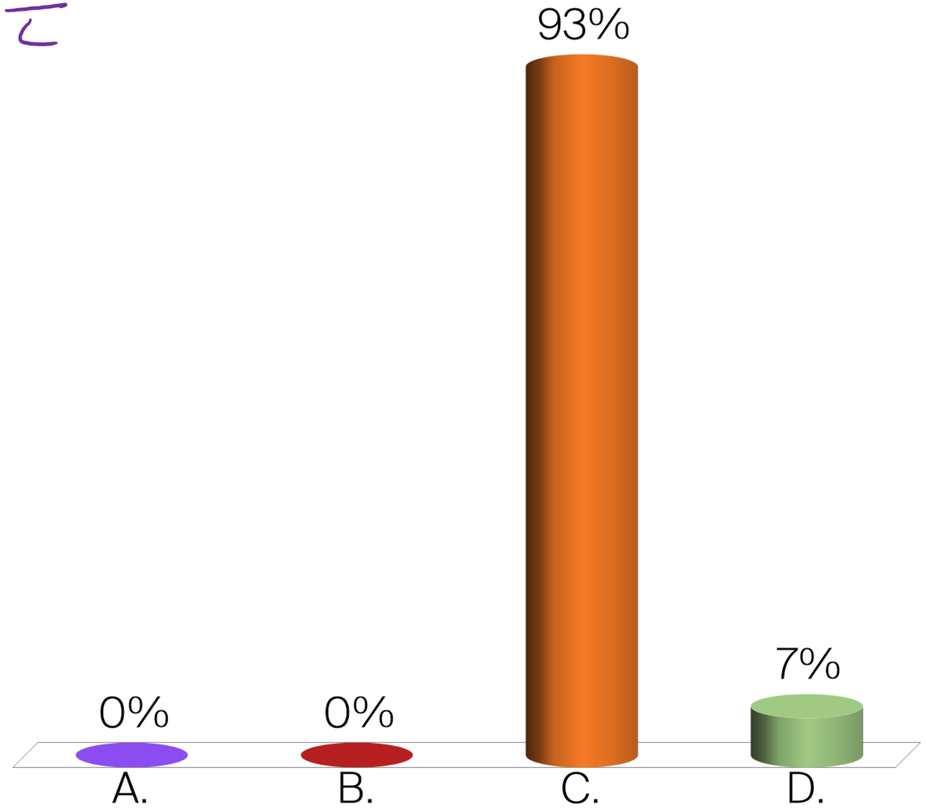
$T = \frac{1}{2} m l^2 \dot{\theta}^2$

$V = \frac{1}{2} k \left(\frac{3}{4} l \theta\right)^2 + mg l \left(\frac{\theta^2}{2}\right)$

$m l^2 \ddot{\theta} + k \left(\frac{3}{4} l\right)^2 \theta + mgl\theta = 0$

$\omega_0^2 = \frac{9}{16}\frac{k}{m} + \frac{g}{l}$





Régime permanent – Maximum Amplitude

A. δ

B. $\omega_2 = \omega_0\sqrt{1-2\eta^2}$

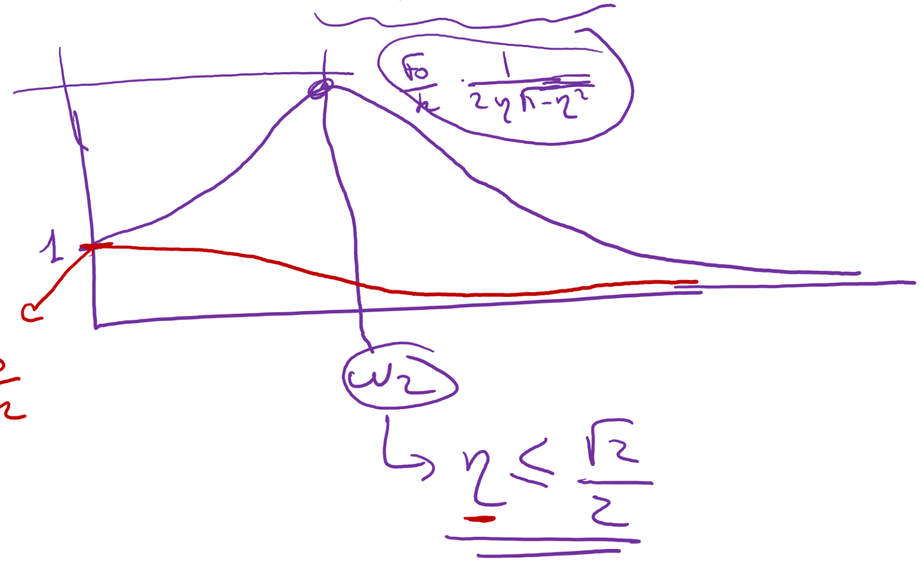
C. F_0/k

D. $\dfrac{F_0/k}{2\eta\sqrt{1-\eta^2}}$

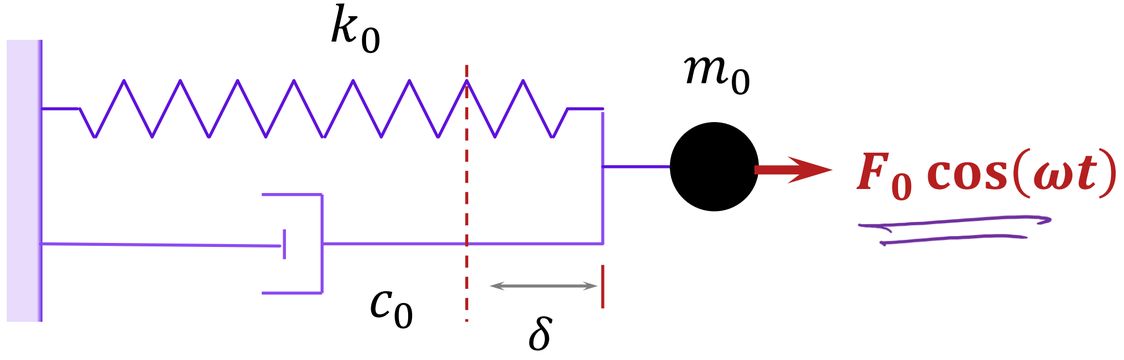
E. On ne peut pas savoir

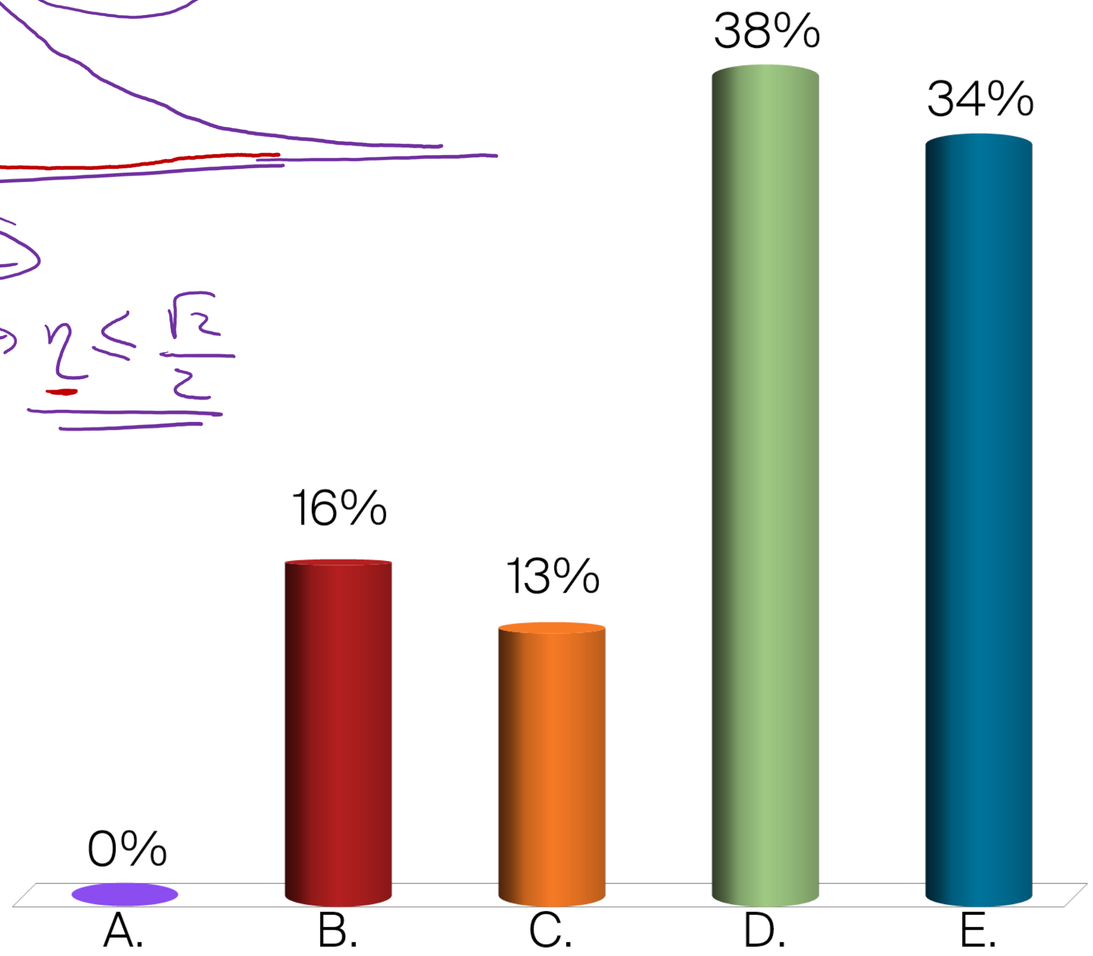
$$x(t) = X_0 \cdot M(\omega) \cdot \cos(\omega t - \varphi)$$

$$= \frac{F_0}{k} \cdot \frac{1}{\sqrt{(1-\beta^2)^2 + 4\eta^2\beta^2}} \cdot \cos(\omega t - \varphi)$$



$\omega_2 \rightarrow \eta \leq \frac{\sqrt{2}}{2}$





X_1, si $\omega = \sqrt{\frac{k_0}{m_0}}, \eta = 0.01$?

A. $100\frac{F}{k_0}$

B. $50\frac{F}{k_0}$

C. $0.01\frac{F}{k_0}$

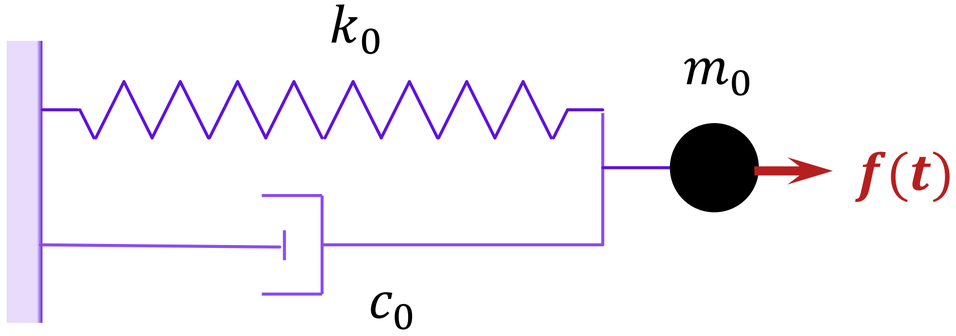
D. 0

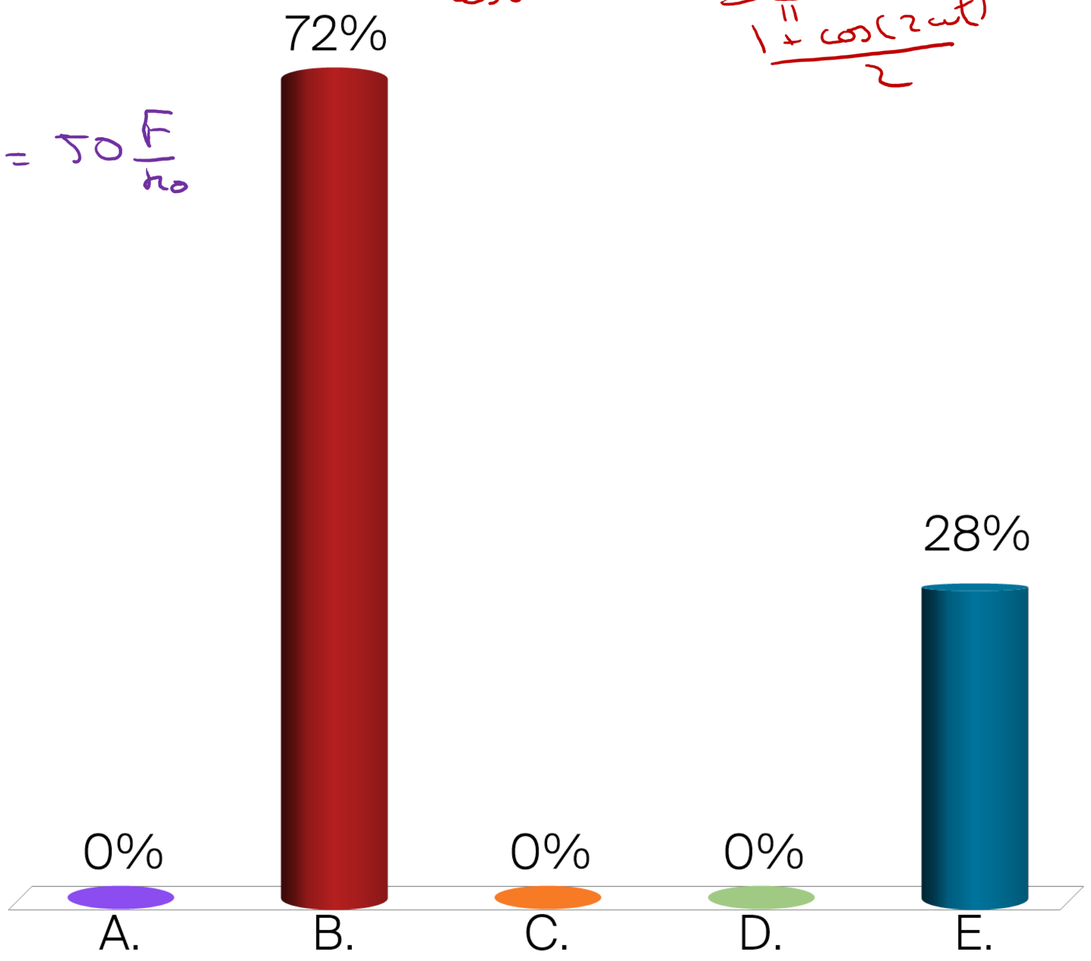
E. Aucune réponse dessus

$$x_1(t) = \frac{F}{k_0}\cdot\frac{1}{\sqrt{(1-\beta^2)^2+4\eta^2\beta^2}}\cos(\omega t-\varphi_1)$$

$$X_1 = \frac{F}{k_0}\cdot\frac{1}{2\eta} = \frac{100}{2}\frac{F}{k_0} = 50\frac{F}{k_0}$$

$$f(t) = F\cos(\omega t)\,(1+\cos(\omega t)) = F\cos(\omega t) + F\cos^2(\omega t) = \frac{F}{2} + F\cos(\omega t) + \frac{F}{2}\cos(2\omega t)$$





Regime permanent harmonique, pour quelle valeur de η on a $\varphi = 45°$?

$\varphi = \arctan\left(\frac{2\eta\beta}{1-\beta^2}\right)$

$\frac{2\eta\beta}{1-\beta^2} = 1 \Rightarrow \eta = \frac{1-\beta^2}{2\beta}$

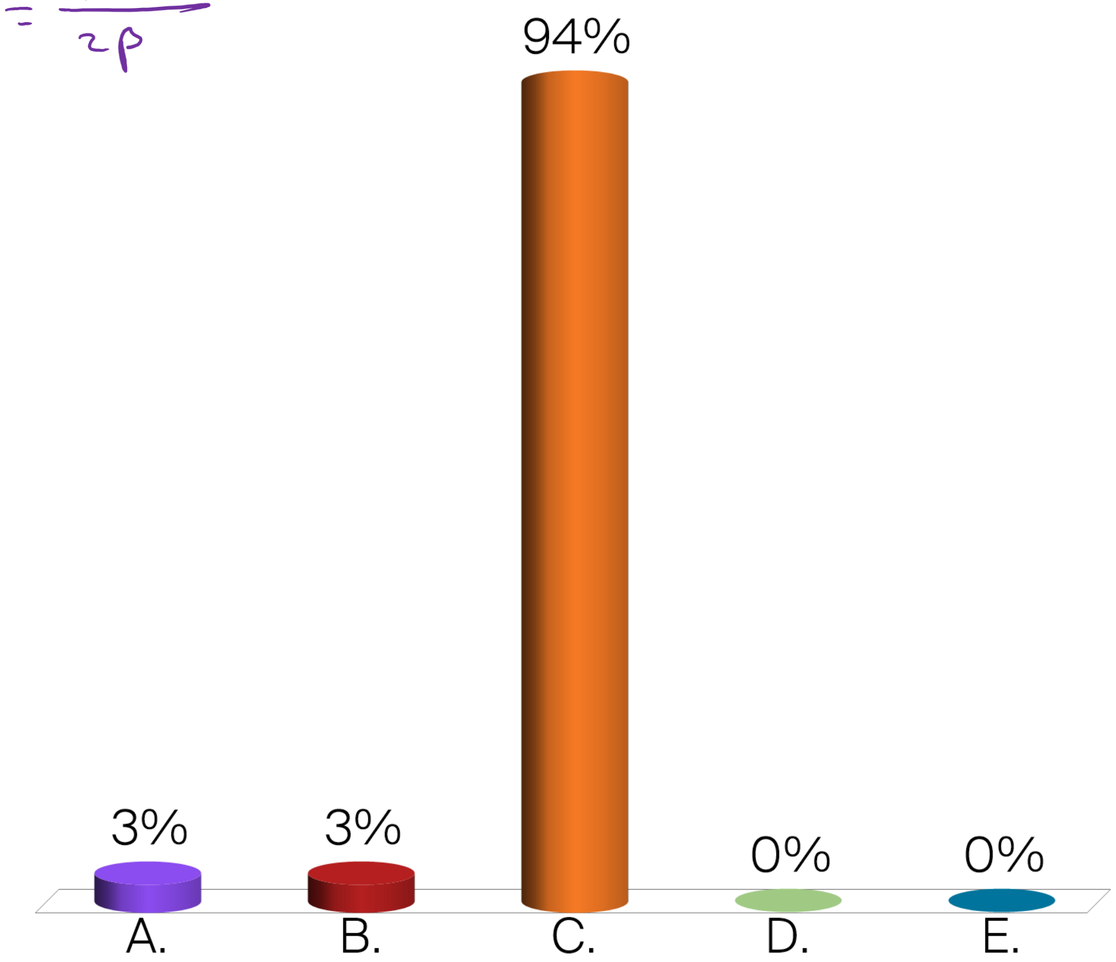
A. $\eta = 0$

B. $\eta = 1 - \beta^2$

C. $\eta = \frac{1-\beta^2}{2\beta}$

D. $\eta = 1 - \frac{\beta}{2}$

E. Impossible

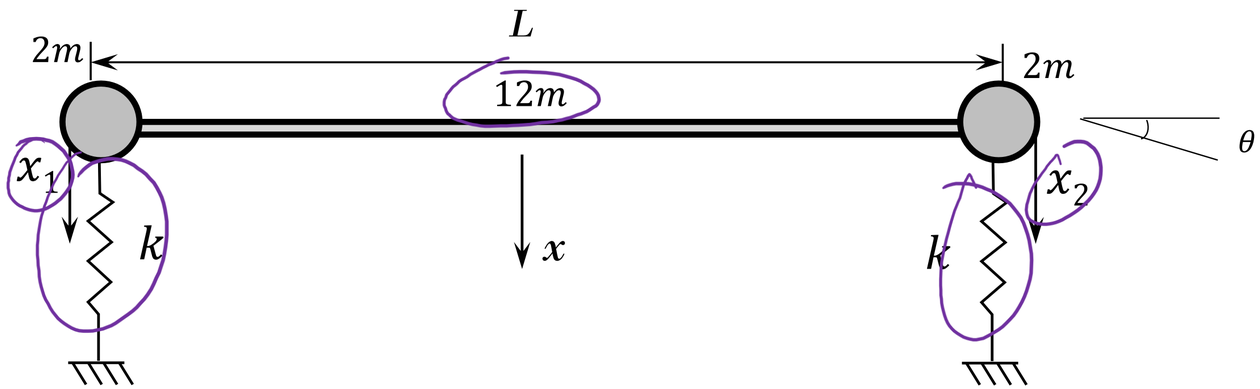


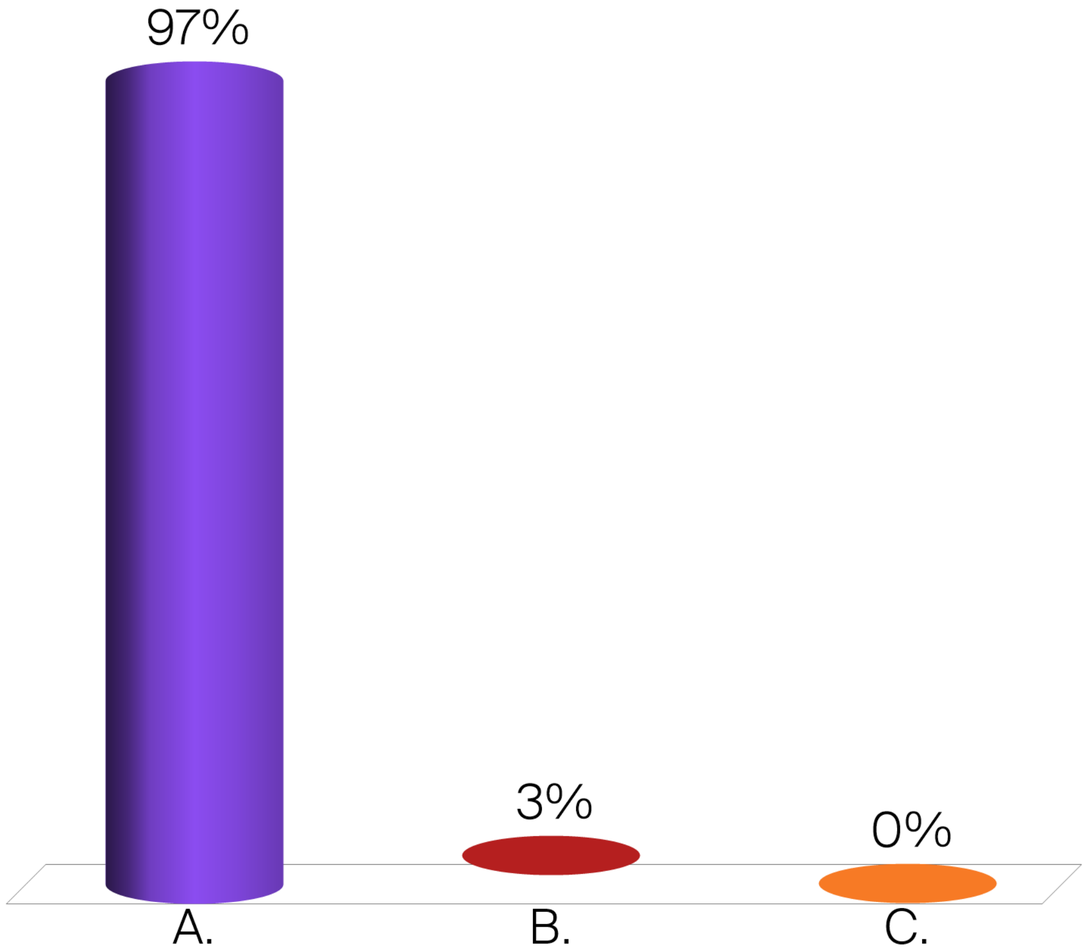
Energie Potentielle

A. $V = \frac{1}{2}kx_1^2 + \frac{1}{2}kx_2^2$

B. $V = kx_1^2 + kx_2^2$

C. $V = 2kx_1^2 + 2kx_2^2$





Energie cinétique

A. $T = 3m\dot{x}_1^2 + 3m\dot{x}_2^2 + 2m\dot{x}_1\dot{x}_2$

B. $T = 6m\dot{x}_1^2 + 6m\dot{x}_2^2 + 2m\dot{x}_1\dot{x}_2$

C. $T = 2m\dot{x}_1^2 + 2m\dot{x}_2^2 + 4m\dot{x}_1\dot{x}_2$

D. $T = 4m\dot{x}_1^2 + 4m\dot{x}_2^2 - 2m\dot{x}_1\dot{x}_2$

$T = \frac{1}{2}2m\dot{x}_1^2 + \frac{1}{2}2m\dot{x}_2^2 + \frac{1}{2}12m\cdot\dot{x}^2 + \frac{1}{2}J\dot{\theta}^2$

$J = \frac{1}{12}12m\cdot L^2 = mL^2$

$J = \int dm\cdot x^2 = \frac{12m}{L}\int_{-L/2}^{L/2} x^2\,dx = \frac{12m}{L}\cdot\frac{x^3}{3}\Big|_{-L/2}^{L/2}$

$x = \frac{x_1+x_2}{2}$ $\quad \theta = \frac{x_2-x_1}{L}$