Prerequisites Survey/Test
ME 460/660: Mechanical Vibrations
Instructor – Dr. Joseph C. Slater

Students Name: _____ **Score:** _____ points out of 10 points

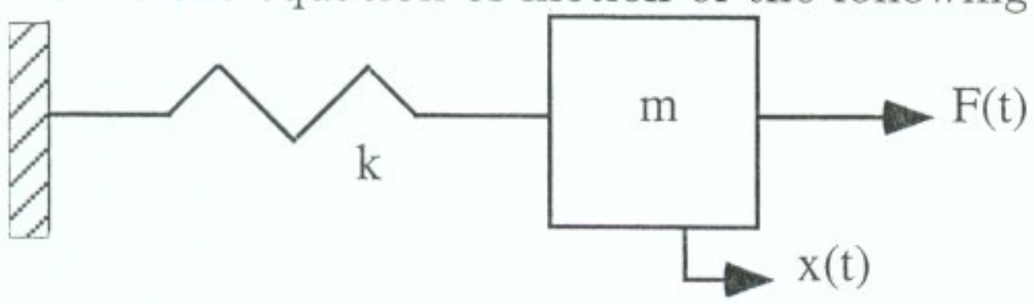
The purpose of this survey/test is to assess how prepared you are for this course and to see how well the prerequisite courses are covering the material required for this course. Please fill out the general information on each course, check the appropriate box that best describes the level of understanding that you feel you have for the topic, and then work out the test question. This test will constitute 5% of your grade for this quarter. Note that no test points are given or deducted for how you respond to the student assessment portion of the form.

General Information on Prerequisite Course				
Course	*Where Taken*	*Term/Year*	*Instructor*	*Grade (4.0 scale)*
ME 213: Dynamics				

Student Assessment of Their Knowledge of Prerequisite Topic for Course Listed Above				
Topic	ABET Topic Letters	Check box below applicable response		
		Can Explain or Apply Concept	*Heard of Topic*	*Never Heard of Topic*
Free Body Diagrams	A			

Test Question Assessment of Student's Prerequisite Knowledge

Question: Derive the equation of motion of the following system:



Answer:

$$\sum F = m\ddot{x}$$

$$m\ddot{x} + kx = F(t)$$

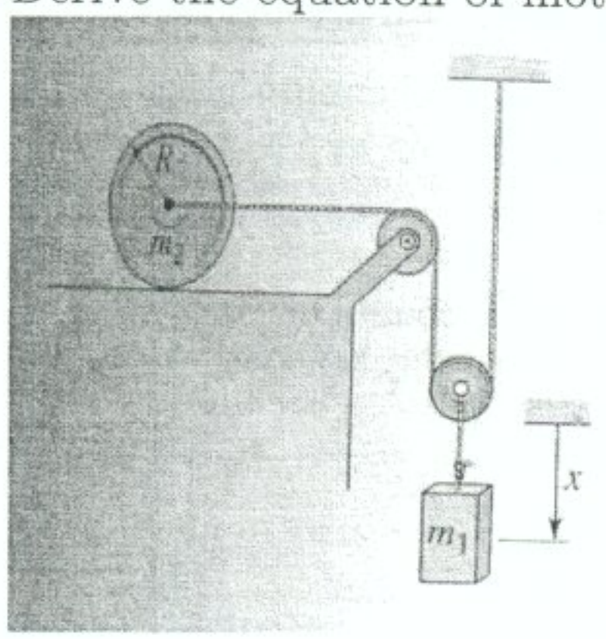
Grade:_____ out of 2 points

General Information on Prerequisite Course				
Course	*Where Taken*	*Term/Year*	*Instructor*	*Grade (4.0 scale)*
ME 213: Dynamics				

Student Assessment of Their Knowledge of Prerequisite Topic for Course Listed Above				
Topic	ABET Topic Letters	Check box below applicable response		
		Can Explain or Apply Concept	*Heard of Topic*	*Never Heard of Topic*
Kinematics and Kinetics	A			

Test Question Assessment of Student's Prerequisite Knowledge

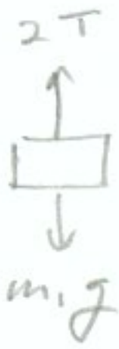
Question: Derive the equation of motion of the following system:



$y = 2x$

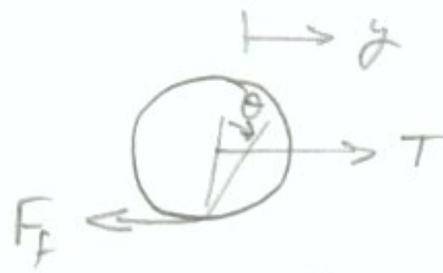
$y = \theta R_1$ (Rolling without slipping)

Answer:



$\Sigma F = m_1 \ddot{x}$

$m_1 g - 2T = m\ddot{x}$ ①



$\Sigma F = m_2 \ddot{y} = T - F_f$ ②

$\Sigma M = J\ddot{\theta} = F_f R$ ③

$F_f = \frac{J}{R}\ddot{\theta}$ ④

sub ④ into ②

$m_2\ddot{y} = T - \frac{J}{R}\ddot{\theta}$

$\left(m_2 + \frac{J}{R^2}\right)\ddot{y} = T$ ⑤

sub ⑤ into ①

$m_1 g = m_1\ddot{x} + 2\left(m_2 + \frac{J}{R^2}\right)\ddot{y}$

$$m_1 g = \left(m_1 + m_2 + \frac{J}{R^2}\right)\ddot{x}$$

Either

We know there is rolling without slipping because the problem statement asked for a single equation

OR

$y \neq \theta R_1$ and we substitute ② into ① for the first eqn, and ③ is the second equation. $F_f = \mu_k m_2 g$

Grade:_____ out of 4 points

General Information on Prerequisite Course				
Course	*Where Taken*	*Term/Year*	*Instructor*	*Grade (4.0 scale)*
EE 321: Linear Systems I				

Student Assessment of Their Knowledge of Prerequisite Topic for Course Listed Above				
Topic	ABET Topic Letters	Check box below applicable response		
		Can Explain or Apply Concept	*Heard of Topic*	*Never Heard of Topic*
Laplace transform of differential equation	A			

Test Question Assessment of Student's Prerequisite Knowledge

Question: Find the *Laplace domain* solution of $x(t)$, $X(s)$, given the governing equation $\ddot{x} + 0.1\dot{x} + 4x = \sin(3t)$ and $\mathcal{L}(\sin(at)) = \frac{a}{s^2+a^2}$.

Answer:

$$X(s) = \frac{a}{s^2+a^2} \quad \frac{1}{s^2+.1s+4}$$

Grade:_____ out of _2_ points

General Information on Prerequisite Course				
Course	*Where Taken*	*Term/Year*	*Instructor*	*Grade (4.0 scale)*
EE 321: Linear Systems I				

Student Assessment of Their Knowledge of Prerequisite Topic for Course Listed Above				
Topic	ABET Topic Letters	Check box below applicable response		
		Can Explain or Apply Concept	*Heard of Topic*	*Never Heard of Topic*
Fourier series	A			

Test Question Assessment of Student's Prerequisite Knowledge

Question: Find the first three term of the Fourier series of the repeating function for which $x(t) = 0$ from $t = 0$ to $t = 1$, and $x(t) = -1$ from $t = 1$ to $t = 2$, repeating every 2 seconds.

Hint:

$F(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos(n\omega_T t) + b_n \sin(n\omega_T t))$ where $\omega_T = 2\pi/T$, and T is the period of the function

$a_0 = \frac{2}{T} \int_0^T F(t)dt$,

$a_n = \frac{2}{T} \int_0^T F(t)\cos(n\omega_T t)dt$, and

$b_n = \frac{2}{T} \int_0^T F(t)\sin(n\omega_T t)dt$

Answer:

You're welcome to do the math, but $a_n = 0$, $n = 0, \ldots \infty$

$$b_n = \int_0^1 \sin \frac{2\pi n t}{T} dt + \int_1^2 -\sin \frac{2\pi n t}{T} dt$$

$$= 2\int_0^1 \sin \pi n t \, dt = \frac{-2}{\pi n} \cos \pi n t \Big|_0^1$$

$$= \frac{-2}{\pi n}\left(-1 + (-1)^n\right) = \begin{cases} \frac{4}{\pi n} & n \text{ odd} \\ 0 & n \text{ even} \end{cases}$$

$$F(t) \approx \frac{4}{\pi} \sin \pi t + \frac{4}{3\pi} \sin 3\pi t + \frac{4}{5\pi} \sin 5\pi t + \cdots$$

Grade:_____ out of 2 points