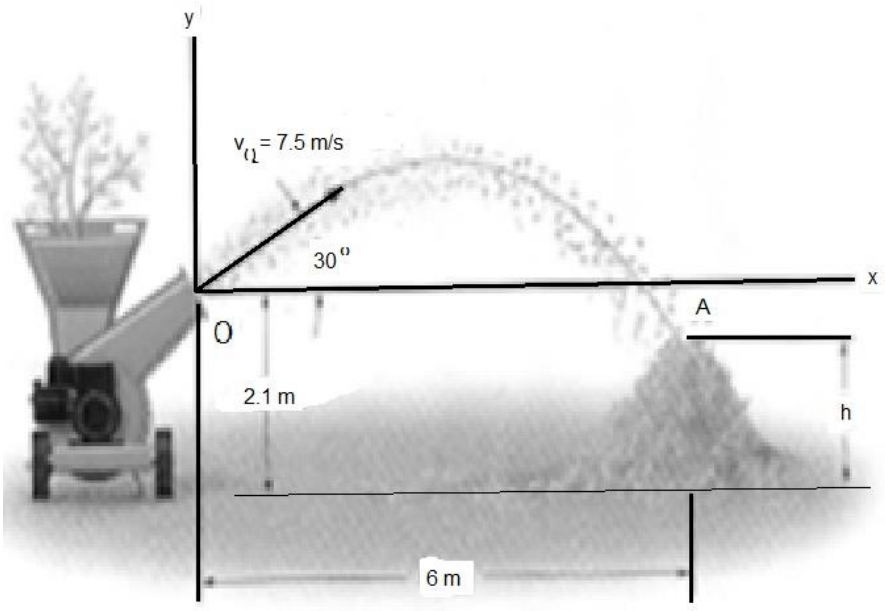
COURSE: Dynamics	**NUMBER** ENGR 243/4	**SECTION** T, V, X, TT and Y	
Final Examination	**DATE: Friday, April 19, 2013**	**TIME 19:00 – 22:00 hours**	**# OF PAGES **** **4**
INSTRUCTOR: Drs. A. Paradis, T. Stathopoulos, Y. Zeng and Z. Keshavarz Motamed			
MATERIALS ALLOWED	[X] **NO**	[ ]	
CALCULATORS ALLOWED	[ ] **NO**	[X] **YES (ENCS Approved)**	

SPECIAL INSTRUCTIONS:

1. Answer all the questions. All questions carry equal marks.
2. Show relevant steps with intermediate results required in answering all the questions.
3. If you think that any data is missing, state your assumptions clearly and proceed with your Answers.

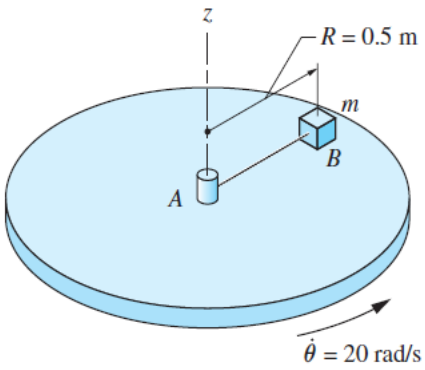
Question #1

The chipping machine shown ejects wood chips at v_o = 7.5 m/s. If the tube is oriented at 30° from the horizontal, determine how high, h, the chips strike the pile if they land on the pile 6 m from the tube.



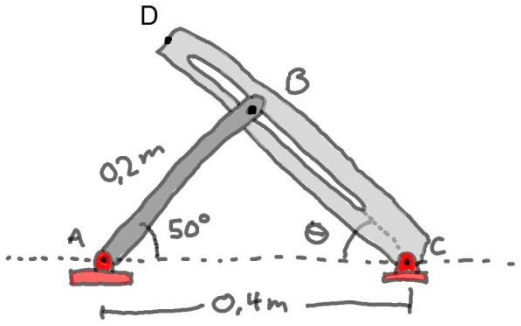
Question #2

The circular table in the figure is being driven at a constant angular speed, $\dot{\theta} = 20$ rad/s about the vertical z-axis. The block B of mass m is placed on the rotating table with zero initial velocity with the string AB stretched tight. If the block slips for 3.11 s before reaching the speed of the table, determine the coefficient of kinetic friction between the block and the table.



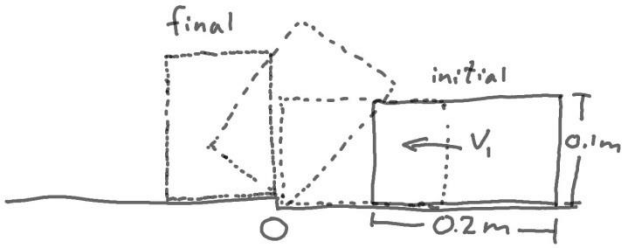
Question #3

Rod AB is rotating clockwise with a constant angular velocity of 4 rad/s. Find the angular velocity and the angular acceleration of the rod DC (no friction).



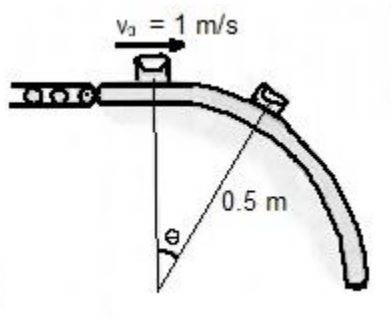
Question #4

The rectangular block ($\bar{I}$ = (1/12)m(b^2 + c^2)) is sliding without friction to the left on the horizontal surface. It has a velocity of v_1 when it hits a small step at O. Assume negligible rebound at the step and find the minimum value of v_1 which will permit the block to pivot freely about O and reach a standing position with no velocity (b = 0.2 m & c = 0.1 m).



Question #5

Packages having a mass of 2 kg are delivered from a conveyor to a **smooth** circular ramp with a velocity of v_o = 1 m/s as shown. If the radius of the ramp is 0.5 m, determine the max angle θ at which each package begins leaving the surface.



Formula sheet :

$$v = v_0 + a(t - t_0)$$

$$v^2 = {v_0}^2 + 2a(x - x_0)$$

$$x = x_0 + v_0(t - t_0) + \frac{a}{2}(t - t_0)^2$$

$$\vec{v} = v\overrightarrow{e_t}$$

$$\vec{a} = a_t\vec{e}_t + \frac{v^2}{\rho}\vec{e}_n$$

$$\vec{r} = r\overrightarrow{e_r}$$

$$\vec{v} = \dot{r}\,\overrightarrow{e_r} + r\dot{\theta}\overrightarrow{e_\theta}$$

$$\vec{a} = \left[\ddot{r} - r\dot{\theta}^2\right]\overrightarrow{e_r} + \left[2\dot{r}\dot{\theta} + r\ddot{\theta}\right]\overrightarrow{e_\theta}$$

$$\overrightarrow{v_B} = \overrightarrow{v_A} + \overrightarrow{v_{B/A}}$$

$$x = x_0 + v_{x0}(t - t_0)$$

$$y = y_0 + v_{y0}(t - t_0) - 4.905(t - t_0)^2$$

$$v_y = v_{y0} - 9.81(t - t_0)$$

$${v_y}^2 = {v_{y0}}^2 - 19.62(y - y_0)$$

$$\vec{v} = \vec{\omega} \times \vec{r}$$

$$\vec{a} = \vec{\alpha} \times \vec{r} + \vec{\omega} \times (\vec{\omega} \times \vec{r})$$

$$\overrightarrow{a_B} = \overrightarrow{a_A} + \vec{\alpha} \times \vec{r} + \vec{\omega} \times (\vec{\omega} \times \vec{r}) + 2\overrightarrow{\Omega} \times \dot{\vec{r}}$$

$$\sum \vec{F} = m\vec{a}$$

$$\sum \vec{M} = I\vec{\alpha}$$

$$\overrightarrow{H_0} = \vec{r} \times m\vec{v}$$

$$U_{1\to2} = \int \vec{F} \cdot d\vec{r}$$

$$U_{1\to2}^{tot} = \Delta T \ , \ T = \tfrac{1}{2}mv^2$$

$$P = \frac{dU}{dt} = \vec{F} \cdot \vec{v}$$

$$\frac{1}{2}m{v^2}_1 + mgy_1 + \frac{1}{2}k{x^2}_1 + U_{1\to2}^{nc} = \frac{1}{2}m{v^2}_2 + mgy_2 + \frac{1}{2}k{x^2}_2$$

$$m\overrightarrow{v_1} + \int \vec{F}dt = m\overrightarrow{v_2}$$

$$e = \frac{{v_2}` - {v_1}`}{v_1 - v_2}$$

$$U_{1\to2} = \int \vec{M} \cdot d\vec{\theta}$$

$$T = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$