ELECTROMECHANICAL ANALYSIS LAB
EMET 3424_70
TUESDAY, APRIL 10, 2001
8:00 – 9:50AM, SET 363

LAB#9

PUNCH PRESS ANALYSIS

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LAB OBJECTIVE

The objective of this laboratory experiment is to gain experience and practice working with electrical devices. We will look at the flywheel characteristics. We will use an angular velocity transducer mechanism to converts circular velocity into voltage.

The equipment used in this lab is listed but limited to this list.

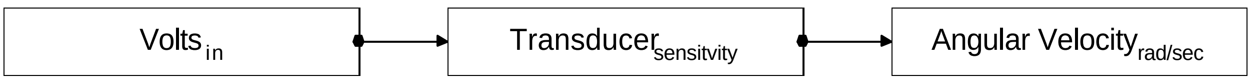
- Tektronix TDS 310 Two Channel Oscilloscope, S/N B040281, Instr. TDS310, Voltage Range: 90 – 132 V, Frequency Range: 47 – 440 Hz
- Alva F Allen Punch Press; Model BT-5-KFE34526; 5 Ton; Clinton, MO, USA
- Westing House AC Motor, S# 315P102-A, Ser: O5k, Type FHT, HP: 1/3, RPM: 1725, Volts: 115, Amp: 6.3
- Angular Velocity Transducer
- Tachometer

PUNCH PRESS ANALYSIS

THEORY

A punch press flywheel exhibits some expected and repeatable characteristics. In order for the flywheel to reach full velocity it must over come the moment of inertia. In order for that same flywheel to slow down it must over come the moment of inertia and frictional torque.

FIGURE 1: BLOCK DIAGRAM PUNCH PRESS ANALYSIS



The angular velocity transducer will produce an output voltage. We will then determine the transducer sensitivity. The output voltage is then divided by the transducer sensitivity to find the Angular Velocity.

FIGURE 2: TRANSDUCER SENSITIVITY

$$T_s := \frac{SignalOut}{SignalIn}$$

FIGURE 3: ANGULAR VELOCITY

$$\omega := \frac{E_{meas}}{T_s}$$

FIGURE 4: VOLUME OF DISK

$$v := \pi \cdot r^2 \cdot t$$

FIGURE 5: WEIGHT OF DISK

$$w := \gamma \cdot v$$

FIGURE 6: MASS OF DISK

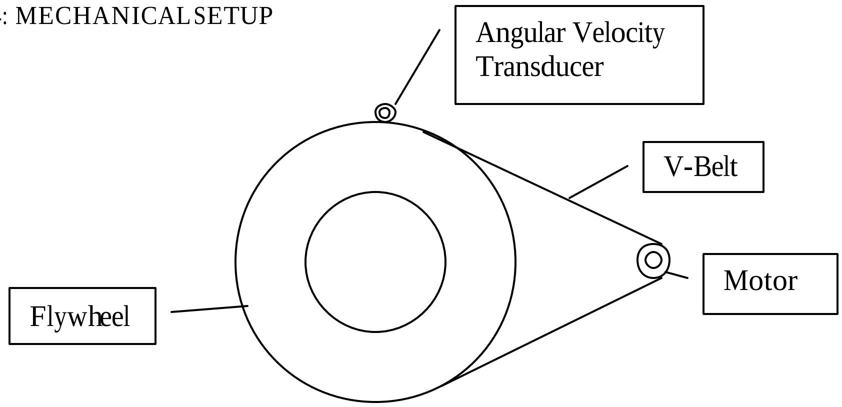
$$mass := \frac{w}{g}$$

FIGURE 7: MOMENT OF INERTIA

$$I := \frac{1}{2} \cdot mass \cdot r^2$$

SCHEMATIC

FIGURE 4: MECHANICAL SETUP



PROCEDURE / DATA COLLECTION

Flywheel is revved up and then down to determine a appropriate time-base scale to set the oscilloscope. Oscilloscope is set to scale. The vertical sensitivity is then set. We then rev up the flywheel. A maximum RPM is taken with tachometer. We measure the output voltage. We rev down the flywheel and measure the output voltage.

CALCULATIONS

$SignalIn := 284.1\,\frac{\pi}{30}$

$SignalOut := 15$

$T_s := \frac{SignalOut}{SignalIn}$

$T_s = 0.504$

$E_{meas} := 10.8$

$\omega := \frac{E_{meas}}{T_s}$

$\omega = 21.421 \cdot time \cdot \frac{rad}{sec}$

$\gamma := .284\,\frac{lb}{in^3}$

$r := 7.25\ in$

$t := 2.125\ in$

$v := \pi \cdot r^2 \cdot t$

$w := \gamma \cdot v$

$w = 99.656 \cdot mass$

$mass := \frac{w}{g}$

$mass = 3.097 \cdot mass \cdot length^{-1} \cdot time^2$

$I := \frac{1}{2} \cdot mass \cdot r^2$

$I = 0.565 \cdot mass \cdot length \cdot time^2$

Frictional Torque

$$\sum M = \sum M_{Eff}$$

$$w - T = I_g a$$

$$29.8 - T = \frac{1}{2} * 2.2988 * 7.25 \wedge 2 * 25.913$$

$$T = -1535.74$$

$$T = 1535.74 - CCW$$

RESULTS SUMMARY

TABLE 1: FORCE CALULATIONS

Rev Up				Rev Down			
Time	Volts	ω	α	Time	Volts	ω	α
sec	volts	Rad/sec	Rad/sec2	sec	volts	Rad/sec	Rad/sec2
0.000	0.0	0.0	0.0	0.0	15.0	29.8	15.8
0.050	0.8	1.6	26.4	1.0	13.4	26.6	-6.4
0.100	1.2	2.4	13.2	2.0	11.4	22.6	-3.1
0.150	1.6	3.2	25.1	3.0	10.2	20.2	-2.9
0.200	2.4	4.8	23.8	4.0	8.4	16.7	-3.6
0.250	2.8	5.6	22.5	5.0	6.8	13.5	-2.4
0.300	3.6	7.1	34.4	6.0	5.8	11.5	-2.5
0.350	4.4	8.7	22.5	7.0	4.2	8.3	-3.1
0.400	4.8	9.5	22.5	8.0	2.8	5.6	-2.4
0.450	5.6	11.1	33.1	9.0	1.8	3.6	-1.4
0.500	6.4	12.7	31.7	9.5	1.2	2.4	-1.9
0.550	7.2	14.3	30.4				
0.600	8.0	15.9	42.3				
0.650	9.2	18.2	30.4				
0.700	9.6	19.0	30.4				
0.750	10.8	21.4	43.6				
0.800	11.6	23.0	21.2				
0.850	12.0	23.8	23.8				
0.900	12.8	25.4	22.5				
0.950	13.2	26.2	34.4				
1.000	14.4	28.6	26.1				
1.050	14.4	28.6	-3.3				
1.100	*14.5*	*28.8*	63.5				
1.150	*15.0*	*29.8*	-335.9				

FIGURE 5: REV UP GRAPH

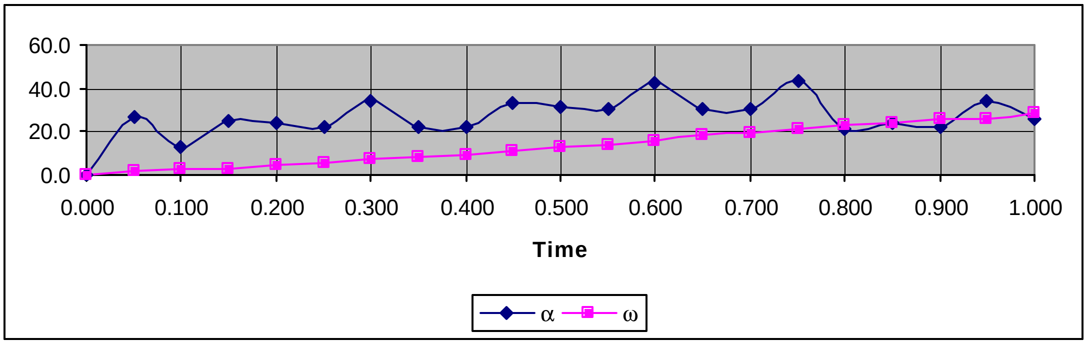


FIGURE 5: REV UP GRAPH

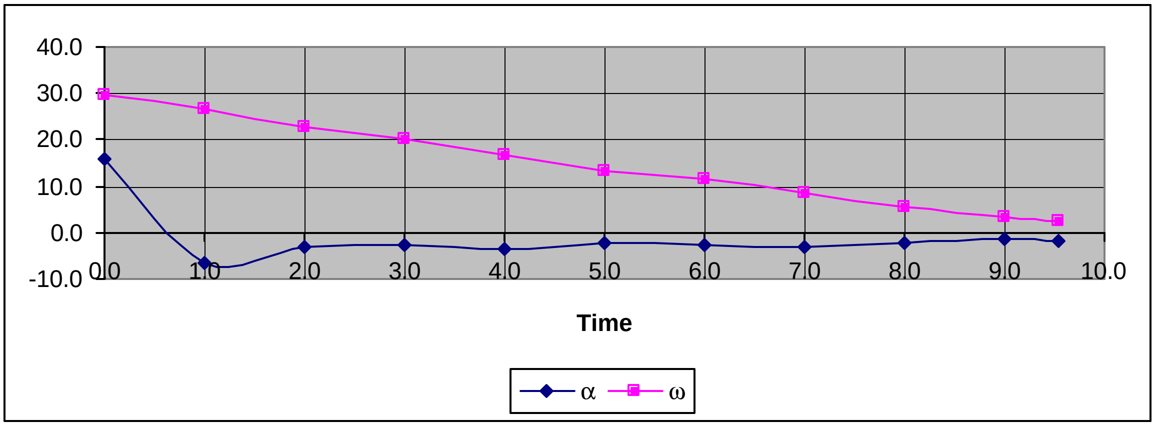


FIGURE 5: FLYWHEEL

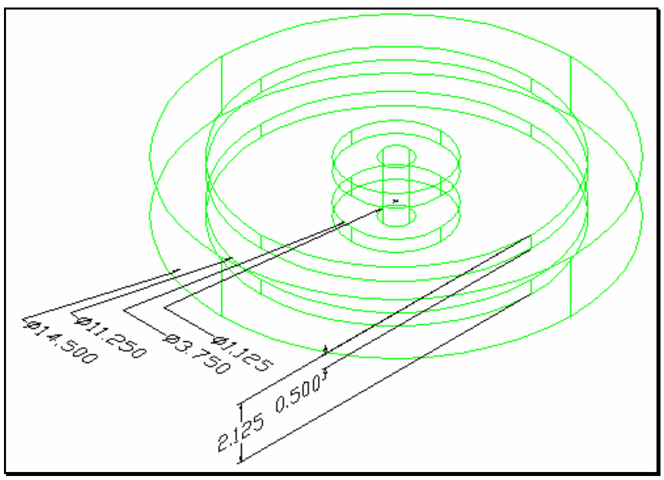


Table 2: Mass Moment of Inertia for the Flywheel

Specific Weight of Steel is γ= 0.284lb/in^3

Shape	Equation	1	2	3	4	Total
Radius	r	7.25	5.625	1.875	0.5625	
Thickness	t	2.125	0.5	0.5	2.125	
Volume	$V=\pi r^2 t$	350.901	49.7009	5.52233	2.11229	260.4314
Total Volume of Flywheel=			260.431in^3			
Weight	$w=\gamma V$	99.6558	14.1151	1.56834	0.59989	73.96251
Mass	m=w/g	3.0974	0.43871	0.04875	0.01865	2.298829
Inertia	$I=(1/2)mr^2$	81.4036	6.94053	0.08569	0.00295	67.69098
Total Mass Moment of Inertia=			67.691slug-ft^2			

Torque	9.239704329	T=Ia	2301.49
Time	0.922402597		

LAB SHEET

NOTES

ORGINAL DATA