IMPLEMENTATION OF ELECTRONIC DRIVER FOR VIBRATION CONTROL OF A PLATE STRUCTURE

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ABSTRACT

- Linear transfer function models based on the experimental data are presented to describe the transverse vibration of a cantilever plate with passive damping (using visoelastic material). An analytical model is used to simulate an experimental system using PSpice E-program for an electronic feed-back control driver to get the total gain for the electronic driver and implement it at the closed loop active control system including the plate dynamic. The analytic control system by using the computer model designed into SIMULINK/MATLAB5.3 performs similar to the experimental system by using the same constant and values as in the experimental active control system.

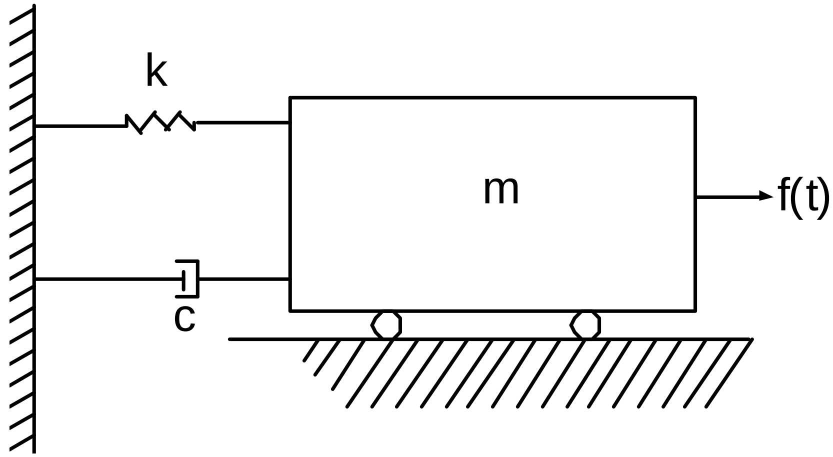

Figure1 Equivalent mass-spring-damper system

So, the Transfer Function of the plate can be written as;

$$Y(s)/F(s) = \frac{1}{(ms^2 + cs + k)} \qquad (3)$$

OR

$$Y(s)/F(s) = \frac{1/m}{(s^2 + (c/m)s + (k/m))} \qquad (4)$$

By the same way, the time response of the closed loop electronic control circuit is presented as shown in Figure 3. The circuit consists of the transfer function of the plate with viscoelastic damping layer and (Gain1) presents the Gain of the feed back control circuit (E-driver). The gain of the feedback electronic circuit is obtained from the analysis of this circuit by Pspice E- program.

the closed loop transfer function for the system became

$$G_{system}(s) = (Y(s)/F(s)) = \frac{G_{plate(s)}}{1 + G_{plate}(s).Gain1(s)} \qquad (10)$$

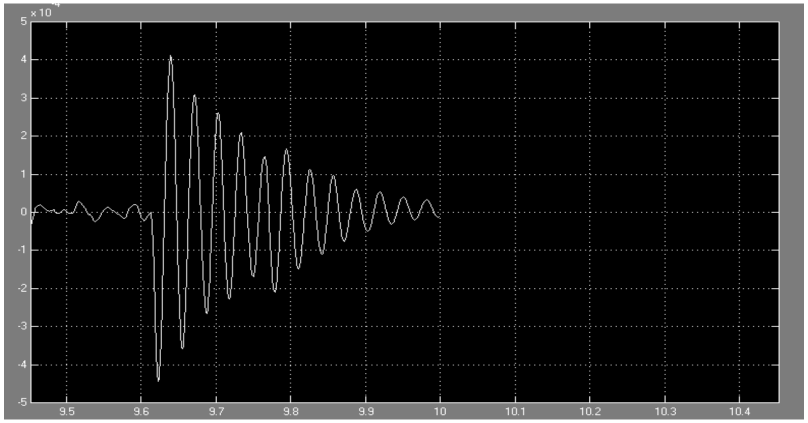

Figure 2 Time response of the[0/90/0/90/3M/90/0/90/0] plate.

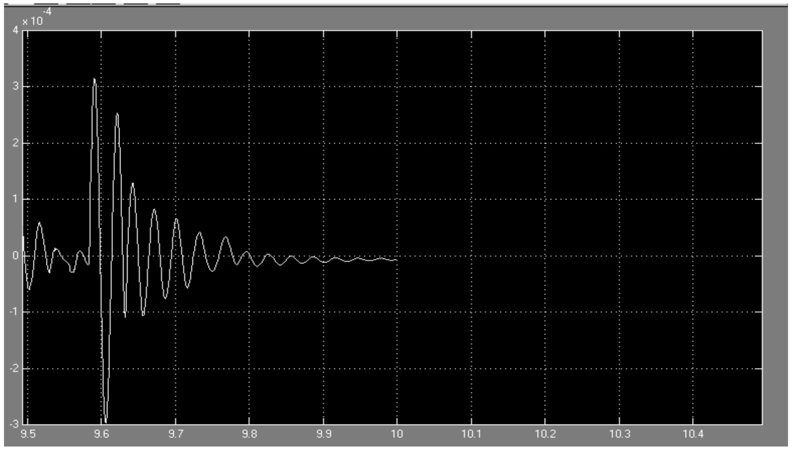

Figure 3 Time response of the[0/90/0/90/3M/90/0/90/0] plate with active control circuit (E-Driver).

Figure 3 present the time response of the plate with viscoelastic layer after actively controlled by using electronic feedback control circuit. The damping ratio optioned is 6.035%. This value of feedback gain is presented to obtain the effect of implementing this gain on the plate structure. Also, to obtain the maximum gain of the complete active control circuit which consist of (Buffer, Phase Shifter, Low Pass Filter, proportional gain amplifier and inverting amplifier) circuits used to drive the piezoelectric actuators.

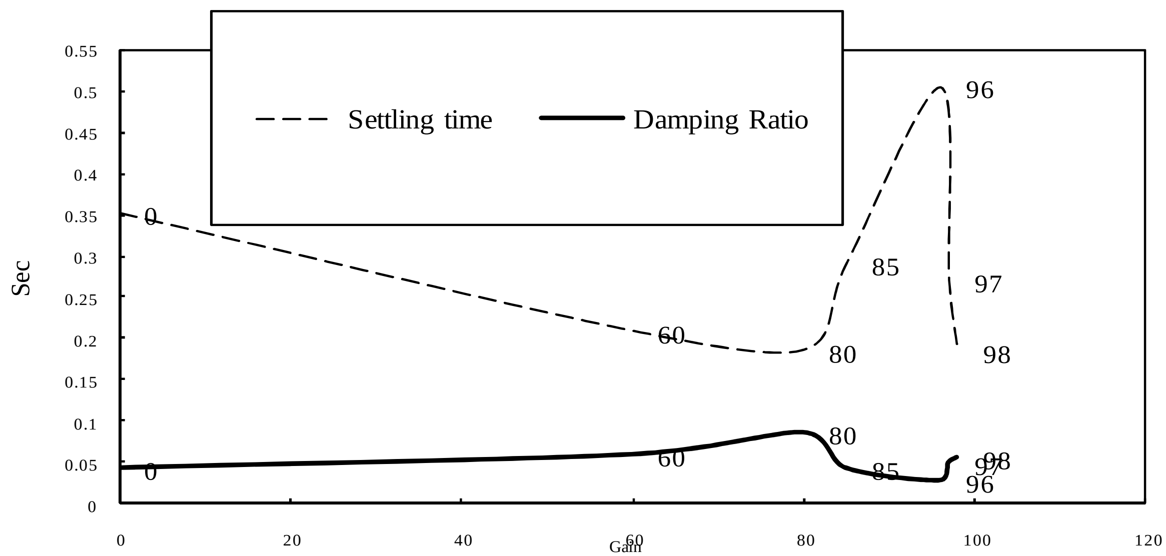

Figure 4 The variation of damping ratio and settling time versus the feedback gain

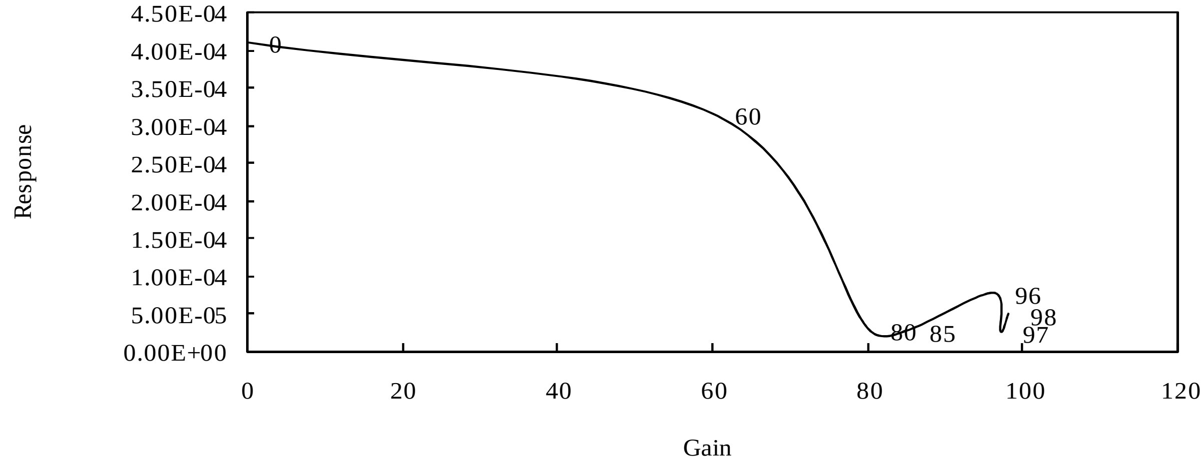

Figure 5 The variation of the max. response versus the feedback gain

The relation between the gain amplitude, the damping ratio, and the time needed for system stability is shown in Figs.4 and 5. It can be seen that the best gain performed to get the best damping ratio 8.7% has an 80-value. The response amplitude has it's low value at gain equal 80. The shortest settling time to reach 2% of the maximum output, and the maximum damping ratio can be obtained when using a feedback gain equal to 80 as shown in Figs. 4 and 5, which gave a 0.1857-Sec., and 8.7%, respectively.

CONCLUSIONS

- An analytical model is used to simulate an experimental system used in privous work [4]. The analytic control system by using the computer model performs similar to the experimental system, and a good damping ratio is achieved when using gain up to 80. The system began to be unstable when using gain value more than 98. The active electronic control circuit can act up to gain 80 to give good reduction in the maximum response value and increase in the damping ratio for the system. Also the settling time for the system is acceptable for gain 60 to 80 and there is a big difference between the settling time for gain values up to 80 and gains values from 85 to 96.