Project #5 — Due Monday, May 3rd, 2004
332: 416 Control System Design

Describing Function Method and Limit Cycles

Consider a linear feedback system with a static nonlinearity. Use the describing method to examine the existence of a limit cycle in the cases given below. Use SIMULINK to draw corresponding block diagrams. Take for the system input the unit step function. Run simulation and observe the existence of sustained oscillations (limit cycle) if any, and measure the magnitude and frequency of oscillations. Compare the results obtained with the results derived analytically in the classroom. Hint: In addition to observing the output signal on the oscilloscope, use the blocck "to workplace" to get the values for the output signal "yout" and the time "tout" in the MATLAB window, then plot "yout" with respect to "tout". From the obtained diagram estimate values for A and ω.

1) The system transfer function is given by

$$G(s) = \frac{1}{s(s+1)(s+2)}$$

and the static nonlinearity is the signum (sign) function whose describing function is given by

$$\mathcal{N}(A,\omega) = \frac{4}{\pi A}$$

2) The system transfer function is given by

$$G(s) = \frac{1}{s(s+1)(s+2)}$$

and the static nonlinearity is the saturation (limiter) function whose describing function is given by

$$\mathcal{N}(A,\omega) = \begin{cases} 1, & 0 \le A \le 1 \\ \frac{2}{\pi}\left(\sin^{-1}\left(\frac{1}{A}\right) + \frac{1}{A}\sqrt{1-\left(\frac{1}{A}\right)^2}\right), & A > 1 \end{cases}$$