Quasi-Optimum Automatic Design for a Feedback Control System by Use of the Digital Computer

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The problem in this paper is to attain the optimum dynamic performance of the system through managing the independent design variables of the compensating network $H(s)$ (cf. Fig. 1). Where $G(s)$ and $H(s)$ are

$$G(s) = -A(s-\alpha)/(s+1)(s+2)\ ,$$

$$H(s) = \frac{K}{k} \cdot \frac{s+kc}{s+c} \cdot \frac{s+d}{s+md}\ .$$

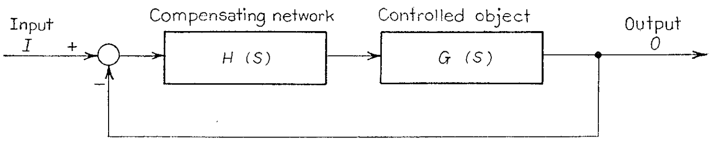

FIG. 1. Feedback Control System

The authors have chosen as the object quantities, the stationary offset (E_{ss}), undershoot (E_m^-), overshoot (E_m^+), and response time (T_r), which are all associated with the indicial response of the system (cf. Fig. 2). The criteria of threshold passing associated with the object quantities are that the magnitude of every object quantity E_{ss}, E_m^-, E_m^+, and T_r should be smaller than the prescribed value. There are conflicting relations among these objective quantities, and how to find the best com-

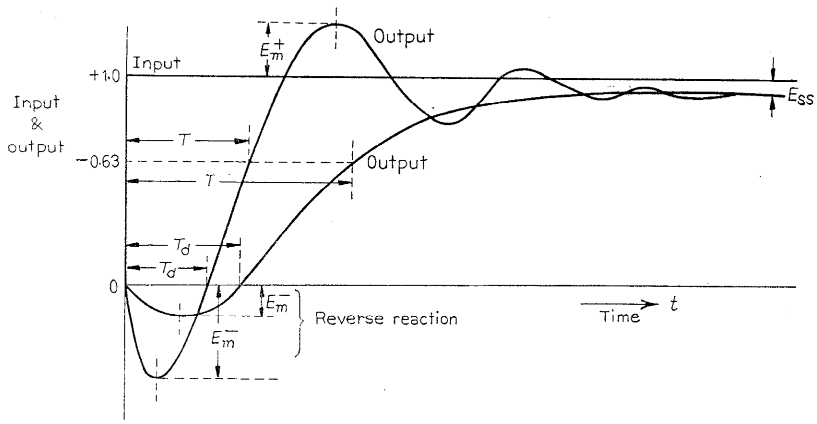

FIG. 2. Object Quantities Associated with Indicial Response

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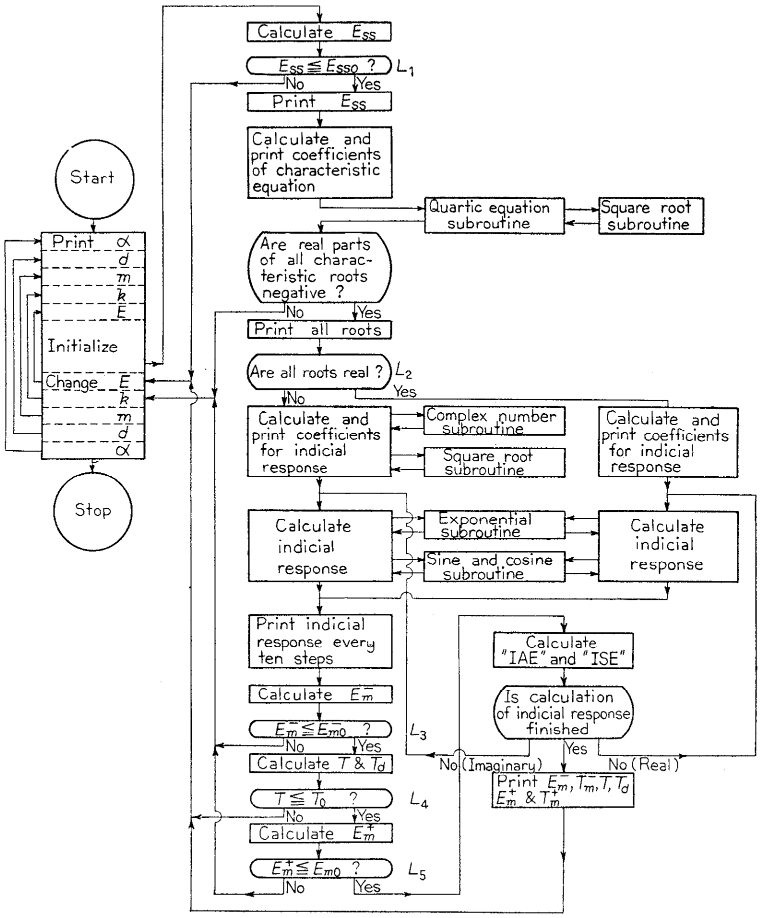

FIG. 3. Flow Diagram for the Experimentation

promise among them is the object of the experimentation.

The design optimization is tried for three design where α, the parameter of the controlled object $G(s)$, is 0.5, 1.0 and 2.0, respectively (cf. Fig. 3). The numerical values assigned to the design variables are as follows:

$$A=1, \quad c=0.01, \quad d=\begin{cases} 1 \\ 2, \\ 3 \end{cases} \quad m=\begin{cases} 3 \\ 6, \\ 10 \end{cases} \quad k=\begin{cases} 50 \\ 100 \\ 200 \\ 300 \end{cases}$$

and $E(=K/k)$=zero to the value in 0.3 step when the system becomes unstables.

To accomodate with the last statement, it is necessary to insert the threshold L_2 that the system should be stable, in addition to the ones already described. The thresholds are arranged in the order so as to minimize the machine time. Some intermediate results of calculations have been typed out in appropriate step of the computer program in order to assist the "learning" of the designer.

The computer mainly used was NEAC 2203, which has a magnetic drum memory of ten digit decimal two thousand words. The average excution time for one step of instruction is roughly 6.7 ms. The total number of words in this computer program is about 1700. The total number of parameter combination for the optimization of three design was about 1,100, and the machine time for a parameter combination was about 7.7 minutes when it passed all the thresholds. The net production machine time for this experimentation was about 90 hours.

Some results of experimentation are shown in Fig. 4.

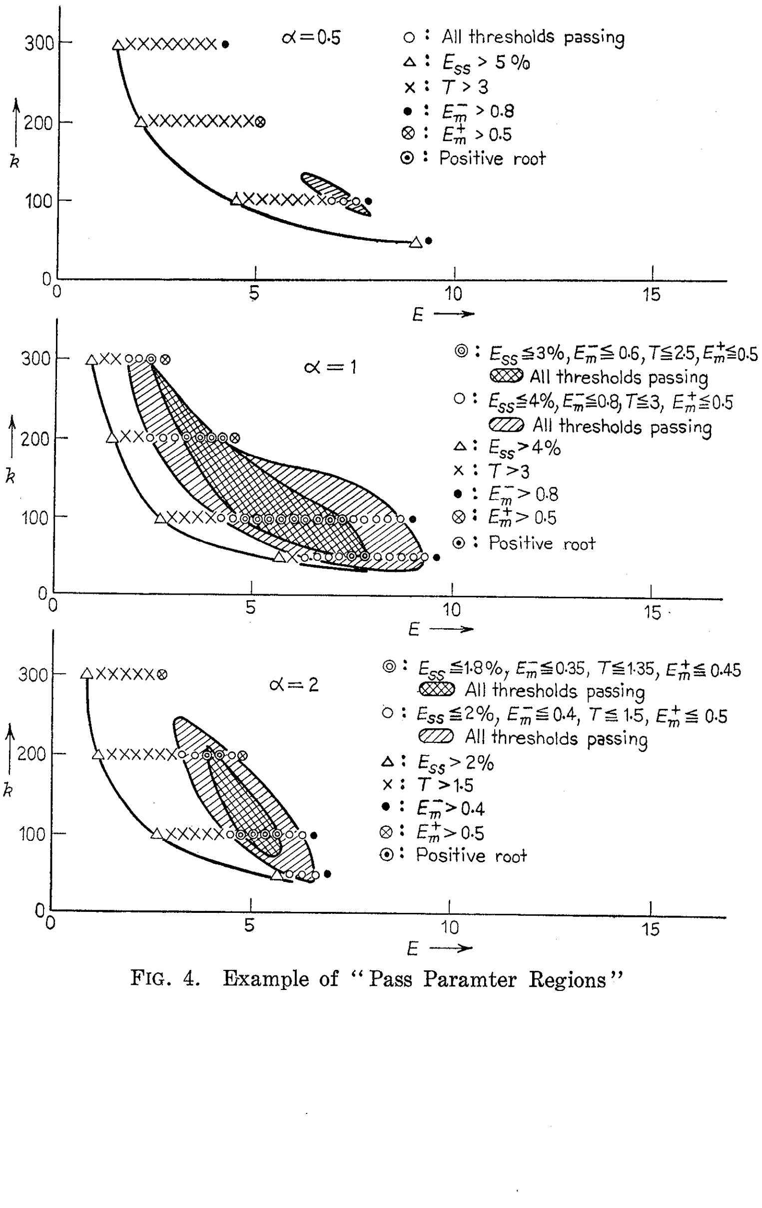

FIG. 4. Example of "Pass Paramter Regions"