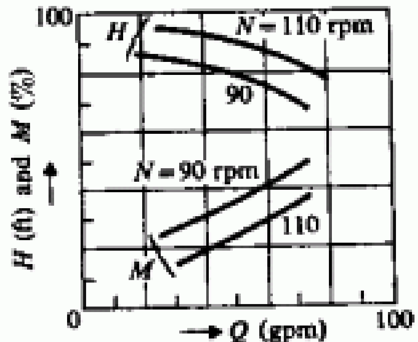
國 立 清 華 大 學 命 題 紙

九十一學年度 工程與系統科學 系（所） 丁 組碩士班研究生招生考試

科目 控制原理 科號 3904 共 二 頁第 一 頁 *請在試卷【答案卷】內作答

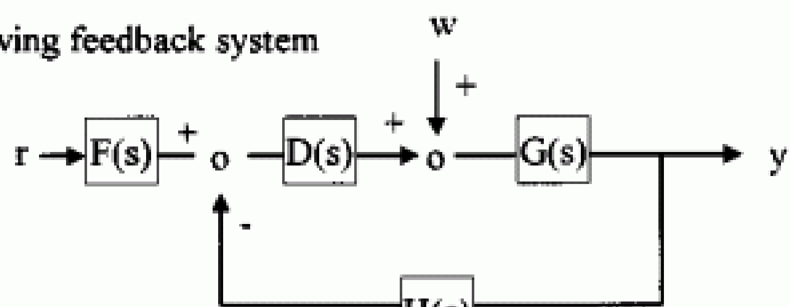
1. The relation between inputs and outputs of pump are $H = f_1(N,Q)$ and $M = f_2(N,Q)$, where N, Q, M, and H are shaft speed, discharge, torque, and head, respectively. A pump characteristic is shown below. Linearize the relation at Q = 50gpm, N = 100rpm, and determine k_{ij} for i, j = 1, 2 defined by the equations,
   $\triangle N = k_{11}\triangle M + k_{12}\triangle H$ and $\triangle Q = k_{21}\triangle M + k_{22}\triangle H$. (20%)



2. In Ziegler-Nichols' ultimate sensitivity method the PID controller gains are adjusted based on evaluating the amplitude and frequency of the oscillations of the system at the limit of stability, i.e., increasing the proportional gain until the system becomes marginally stable. Do you think this method can be applied to any kind of plant? Give your reasons. (10%)

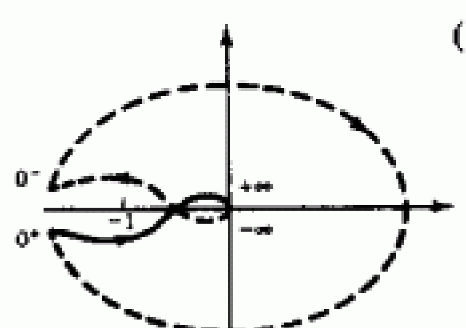
3. Consider the unity feedback system. The open-loop transfer function is given by $G(s) = k/[s(ms^2 + s + 1)]$. Let k = 0.16 and determine the root locus for m. (15%)

4. Consider the following feedback system



   where $G(s) = A/(s^2 + c)$ and $H(s) = 1/(s + a)$. Design the simplest controller D(s) and prefilter F(s) so that the system is type I for a step input r(t). Does it reject the step disturbance w(s)? Prove it. (20%)

5. Consider the Nyquist plot shown below, which is a minimum phase system. Write the corresponding transfer function and indicate the relative location of poles and zero, if exist. (15%)



6. Consider the unity feedback system. The open-loop transfer function $G(s) = 100(1-s)/[(s/0.1 + 1)(s/10 + 1)]$. The controller is chosen as a gain k.

   a. Plot the Bode plots.

   b. Find k to meet (i) phase margin ≧ 60°, (ii) gain margin ≧ 10dB, and (iii) position error ≦ 25%. (20%)