Name: Obot Mkpouto Obot
Matric No: 17/EN/GO4/046
Course title: Servo Mechanism & Control Systems
Course code: EEE 441

Questions / Answers

① Briefly explain the Root locus technique

This is also known as Root locus plot in control system and is used for determining the stability of a given system. Now in order to determine the stability of the system using the root locus ~~tey~~ technique we find the range of value of k for which the complete performance of the system will be satisfactory and the operation is stable.

② Describe the use of Routh Hurwitz to find the stability of a close loop system when:

a) entire row is zero on the Routh table

normal layout for Routh's table

s^4	a_4	a_2	a_0
s^3	a_3	a_1	0
s^2	b_1	b_2	0
s^1	c_1	0	0
s^0	d_1	0	0

$$b_1 = \frac{-\begin{vmatrix} a_4 & a_2 \\ a_3 & a_1 \end{vmatrix}}{a_3} \qquad b_2 = \frac{-\begin{vmatrix} a_4 & a_0 \\ a_3 & 0 \end{vmatrix}}{a_3}$$

$$b_3 = \frac{-\begin{vmatrix} a_4 & 0 \\ a_3 & 0 \end{vmatrix}}{a_3} = 0$$

In the same vain

$$c_1 = \frac{\begin{vmatrix} a_3 & a_1 \\ b_1 & b_2 \end{vmatrix}}{b_1} \qquad c_2 = \frac{-\begin{vmatrix} a_3 & 0 \\ b_1 & 0 \end{vmatrix}}{b_1} = 0$$

$$d_1 = \frac{-\begin{vmatrix} b_1 & b_2 \\ C_1 & 0 \end{vmatrix}}{c_1} = d_1$$

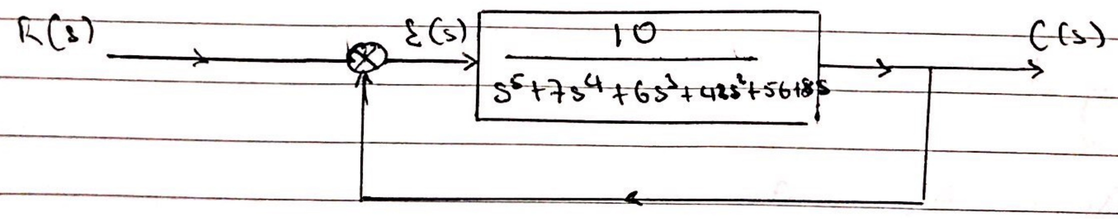
Therefore, standard equation will be

$$b_k = \frac{-\det \begin{vmatrix} a_n & a_{n-2k} \\ a_{n-1} & a_{n-2(k-1)} \end{vmatrix}}{a_{n-1}}$$

When $d(s) = a_n s^n + a_{n-1} s^{n-1} + \text{------} \; a_1 s + a_0$

Example

in a case where a whole row becomes zero



$$T(s) = \frac{10}{s^5 + 7s^4 + 6s^3 + 42s^2 + 56 + 8s}$$

s^5	1	6	8
s^4	7	42	56
s^3	$-\dfrac{\begin{vmatrix} 1 & 6 \\ 7 & 42 \end{vmatrix}}{7} = 0$	$-\dfrac{\begin{vmatrix} 1 & 8 \\ 7 & 56 \end{vmatrix}}{7} = 0$	$\dfrac{\begin{vmatrix} 1 & 0 \\ 7 & 0 \end{vmatrix}}{7} = 0$ ← Entire row is 0

When a row of zero appears, we develop an auxiliary polynomial from s^4 so we have:

$$P(s) = 7s^4 + 42s^2 + 56 \quad — ①$$

Differentiating ①, we will have

$$\frac{dP(s)}{ds} = 28s^3 + 84s \quad — ②$$

∴ we continue with auxiliary equation

s^3 28   84   0

$$s^2 \quad -\frac{\begin{vmatrix} 7 & 42 \\ 28 & 84 \end{vmatrix}}{28} \qquad -\frac{\begin{vmatrix} 7 & 56 \\ 28 & 0 \end{vmatrix}}{28} \qquad -\frac{\begin{vmatrix} 7 & 0 \\ 28 & 0 \end{vmatrix}}{28}$$

$$= 21 \qquad = 56 \qquad = 0$$

$$s^1 = -\frac{\begin{vmatrix} 28 & 84 \\ 21 & 56 \end{vmatrix}}{21} \qquad -\frac{\begin{vmatrix} 28 & 0 \\ 21 & 0 \end{vmatrix}}{21} \qquad 0$$

$$= 28/3 \qquad 0 \qquad 0$$

$$s^0 = -\frac{\begin{vmatrix} 21 & 56 \\ \frac{28}{3} & 0 \end{vmatrix}}{28/3} \qquad 0$$

$$= 56$$

There is no sign change therefore ~~they s~~ the system is marginally stable.

b) To determine the poles on $j\omega$ axis

Ans: when the entries from the row before the row of the zero to the last row are looking at the even polynomials and there are no ~~&~~ sign change then all the poles there belong to the $j\omega$ axis.