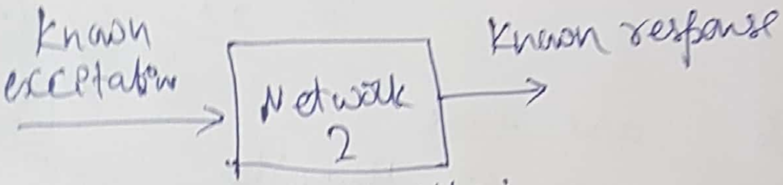
Unit 5 (Network Synthesis) 1

1 Define Network analysis and network synthesis

In network analysis, the network elements are known and excitation (input) is also known and using the various methods, the networks are studied and the response (output) is obtained. So obtaining response for known network and known excitation is called network analysis.

The excitation is known and the response requirement are known, then obtaining for the network for this is known is called network synthesis



N/w Synthesis

2) Write the basis and satisfying conditions of a Hurwitz polynomial.

1. The polynomial P(s) is real when 's' is real
2. The roots of P(s) must be 'zero' or −ve.

3) Test the given polynomial is Hurwitz or not

$P(s) = s^3 + 2s^2 + 4s + 2$

Solution $P(s) = s^3 + 2s^2 + 4s + 2$

$n(s) = s^3 + 4s$ $\quad m(s) = 2s^2 + 2 = s^2 + 1$

$s^2+1)\ s^3+4s\ (s$
$\quad s^3 + s$
$\quad 3s)\ s^2+1\ (s/3$
$\quad s^2$
$\quad 1)\ 3s\ (3s$
$\quad 3s$
$\quad 0$

All the quotients $(2, 2/3, 3/2)$ are positive. So the given polynomial $P(s)$ is Hurwitz

4) Test the given Hurwitz polynomial

$$P(s) = s^4 + s^3 + 4s^2 + 2s + 3$$

Solution :- given $P(s) = s^4 + s^3 + 4s^2 + 2s + 3$

$m(s) = s^4 + 4s^2 + 3$ $\quad n(s) = s^3 + 2s$

$$s^3 + 2s \,)\, s^4 + 4s^2 + 3 \,(\, s$$
$$s^4 + 2s^2$$
$$2s^2 + 3 \,)\, s^3 + 2s \,(\, s/2$$
$$s^3 + 3/2\, s$$
$$1/2\, s \,)\, 2s^2 + 3 \,(\, 4s$$
$$2s^2$$
$$3 \,)\, s/2 \,(\, s/6$$
$$s/2$$
$$0$$

all quotients are +ve
so given $P(s)$ is Hurwitz

5) Write the basic properties of positive real function.

Ans :- 1) The given $F(s)$ is real for real s.
2) The real part of $F(s) \geq$ zero for $Re(s) \geq 0$

$$Re\left[F(s)\right] \geq 0 \text{ for } Re[s] \geq 0$$

3) The function $F(s)$ is rational function.

6) Test whether $F(s) = \dfrac{5(s+1)^2}{s^3 + 2s^2 + 2s + 40}$ is PRF or not

$D(s) = s^3 + 2s^2 + 2s + 40$

$n(s) = s^3 + 2s$ $\quad m(s) = 2s^2 + 40$

6)

$$2s^2+40)\ s^3+2s\ (s/2$$
$$s^3+20s$$
$$-18s)\ 2s^2+40\ (-s/9$$
$$-2s^2$$
$$40)\ -18s\ (\frac{-18s}{40}$$
$$-18s$$
$$(0)$$

The quotient are −ve so D(s) is not a Hurwitz so given F(s) is not a positive real function

7) Test the $F(s) = \frac{3s^2+5}{s(s^2+1)}$ as positive real function

Solution N(s) is even & D(s) is odd polynomial the poles are conjugate. ($s^2=-1$), so Calculate residue

$$F(s) = \frac{3s^2+5}{s(s^2+1)} = \frac{A}{s} + \frac{B}{s-j} + \frac{C}{s+j}$$

$A = 5,$

$B = -1$

$C = -1$

so D(s) is not a Hurwitz and F(s) is not PRF

(8) Find the true realness of given function

$$F(s) = \frac{s^3+5s^2+9s+3}{s^3+4s^2+7s+9}$$

Solution:- $N(s) = s^3+5s^2+9s+3$

So N(s) is Hurwitz

$D(s) = s^3+4s^2+7s+9$

and D(s) is also Hurwitz.

$$5s^2+3)\ s^3+9s\ (s/5$$
$$s^3+3/5\,s$$
$$\tfrac{42}{5}s)\ 5s^2+3\ (\tfrac{25}{42}s$$
$$-5s^2$$
$$3)\ \tfrac{42}{5}s\ (\tfrac{42}{15}s$$
$$-\tfrac{42}{5}s$$
$$(0)$$

$N(s) = s^3 + 5s^2 + 9s + 3$

$n_1 = s^3 + 9s \qquad m_1 = 5s^2 + 3$

$D(s) = s^3 + 4s^2 + 7s + 9$

$n_2 = s^3 + 7s \qquad m_2 = 4s^2 + 9$

To check the ~~the~~ real condition

$$A(\omega^2) = m_1 m_2 - n_1 n_2 \big|_{s=j\omega} \geq 0$$

$$= (5s^2 + 3)(4s^2 + 9) - (s^3 + 9s)(s^3 + 7s) \big|_{s=j\omega}$$

$$= -s^6 + 4s^4 - 6s^2 + 27 \big|_{s=j\omega}$$

$$\geq 0$$

So given function is P.R.F

(9) Write the realization table used in network Synthesis

solution

Element	Z(s)	Y(s)
Resistance R	R	$\frac{1}{R}$
Inductance L	sL	$\frac{1}{sL}$
Capacitance C	$\frac{1}{sC}$	sC

(10) Write the properties of LC Driving point Immittance Function

1. the immittance function is always a ratio of odd to even 'or' even to odd.
2. poles & zero are simple and no multiple poles and zero at any where (either at origin or infinite)

(3) poles and zero are located on the jw axis and they are interlace (alternative) each other

(4) Imaginary poles and zero are conjugate pairs

(5) highest powers of Numerator and denominator are differ by unit

(6) Lowest powers of numerator and denominator are differ by unit

7) There must be either pole or zero at the origin and infinity

8) The Residues at Imaginary axis poles are real and positive

11) Write the properties of RC driving Point Impedance function.

1) poles & ~~zeros~~ are simple. No multiple poles & zeros

2) Poles & zeros are located on negative real axis

3) poles & zeros interlace each other

4) poles & zero are critical frequencies. the first ~~root~~ near to ~~origin~~ origin is always pole

It may located on

5) partial fraction ~~expression~~ expansion of $Z_{RC}(s)$ gives the residues which are always real and positive

6) There is no pole located at Infinity and no zero at origin.

12) Write the properties of RL driving point impedance function. (6)

1) pole and zeros are simple. there is no multiple poles and zeros

2) poles & zero are on -ve real axis and interlace each other

3) The critical frequency near to origin or on origin is always zero

4) The critical frequency greater distance away from origin is always pole (at infinity)

5) There cannot be pole at origin.

6) The value of $Z_{RL}(s)$ at $s=0$ is always less than the value of $Z_{RL}(s)$ at $s=\infty$

13) Test whether the given polynomial is Hurwitz or not $P(s) = s^4 + 2s^2 + 3$

Solution:- $P(s) = s^4 + 2s^2 + 3$

$P'(s) = 4s^3 + 4s$

To find the quotient the expression is

$P(s) / P'(s)$

$$4s^3+4s)\ s^4+2s^2+3\ (s/4$$
$$s^4+s^2$$
$$s^2+3)\ 4s^3+4s\ (4s$$
$$4s^3+12s$$
$$-8s$$

$\boxed{\text{So it is not Hurwitz}}$