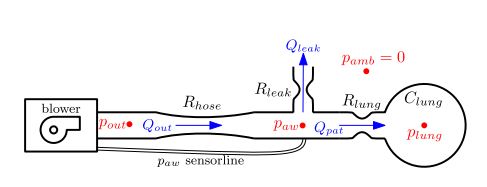
**Task 1:**

Determine the transfer function of the respiratory system shown in Fig. 3

****

Equivalent Electrical Circuit -

+

–

Clung

Rlung

V0

Qpat(I0)

(Ileck)

Plung

Rleak

Qleak

1

Paw

Rhose

Iin

Qout

Pout

(vi)

Pamb = 0

P ⇒ Voltage

Q ⇒ Current

C⇒ Capacitance

R ⇒ resistance

Qout =

Qleak =

Qpat = Qout – Qleak = ...............(i)

.........(ii)

Applying KCL at node 1

⇒

⇒

⇒ Paw = .............(iii)

⇒ Paw = Plung + Pout .......(iv)

Substituting the value of Paw in eqn (i) & (ii)

Qpat = – Plung

= Plung + Paw

Qpat = Plung + Pout .........(v)

Plung = –

= Plung + Pout

Plung = Plung + Pout ........(vi)

Here, input ⇒ Pout , output ⇒ , state ⇒ Plung

From eqn (iv) to (vi) we find:

P­lung= Ah Plung + Bh Pout .........(vii)

= Ch Plung + Dh Pout ..........(viii)

Where,

Ah =

Bh =

Ch =

Dh =

We know that,

Y(s) =

where Y(s) is the output matrix and u(s) is the input matrix

so,

Using the values of parameters given in table 1 of the reference paper, H(s) was calculated using the code given below.

|  |  |
| --- | --- |
| Rlung | 5/1000 |
| Clung | 20 |
| Rleak | 60/1000 |
| Rhose | 4.5/1000 |
| ωn | 2π30 |

Code:

clc;

clearvars;

Rlung = 5/1000;

Clung = 20;

Rleak = 60/1000;

Rhose = 4.5/1000;

Ah = -((1/Rhose)+(1/Rleak))/(Rlung\*Clung\*((1/Rlung)+(1/Rhose)+(1/Rleak)))

Bh = (1/Rhose)/(Rlung\*Clung\*((1/Rlung)+(1/Rhose)+(1/Rleak)))

Ch = [(1/Rlung)/((1/Rlung)+(1/Rhose)+(1/Rleak));...

-((1/Rhose)+(1/Rleak))/(Rlung\*((1/Rlung)+(1/Rhose)+(1/Rleak)))]

Dh = [(1/Rhose)/((1/Rlung)+(1/Rhose)+(1/Rleak));...

(1/Rhose)/(Rlung\*((1/Rlung)+(1/Rhose)+(1/Rleak)))]

s = tf('s');

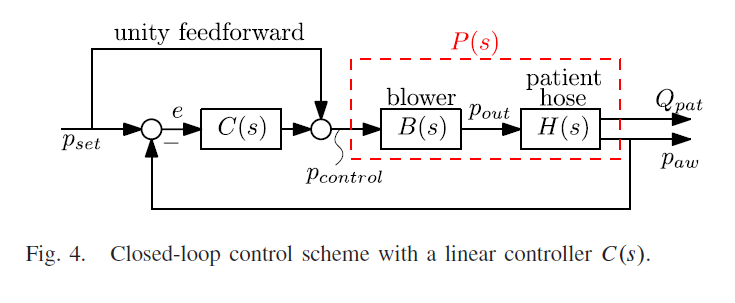
Hs = Ch\*inv((s\*eye(1) - Ah))\*Bh + Dh

So, the calculated H(s) is:

H(s) =

**Task 2:**

Determine the overall transfer function of the closed loop control system shown in Fig. 4.



Changing the diagram to:

Pset

C(s)

B (s)

+

+

+

–

H2 (s)

H1 (s)

Qpat

Paw

Let

C(s) =

Pset(s)

C(s)

P2 (s)

P1 (s)

Qpat (s)

Paw (s)

+

+

+

–

So,

Now,

=

⇒

⇒ …………….. (1)

Again,

Qpat (s)=

=

=

=

⇒

…………………… (2)

By running the following code:

clc;

clearvars;

ki = 1;

wn = 2\*3.1416\*30;

zeta = 1;

s = tf('s');

Hs = [(0.5063\*s + 5.063)/(s + 5.443);...

(101.3\*s + 1.137e-13)/(s + 5.443)];

Bs = (wn^2)/(s^2+(2\*zeta\*wn\*s)+wn^2);

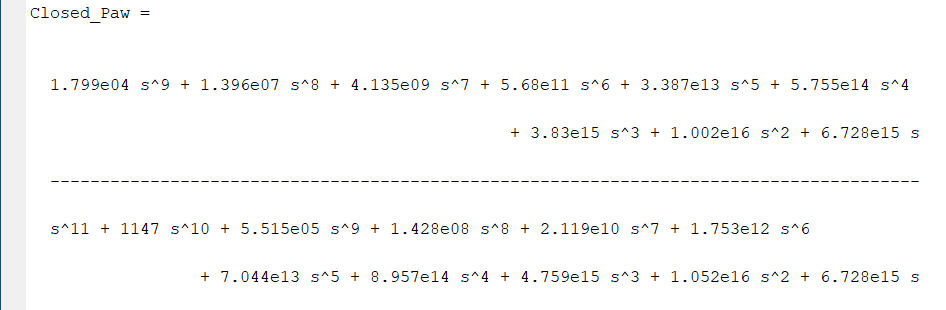
Ps = Hs.\*Bs;

Cs = ki/s;

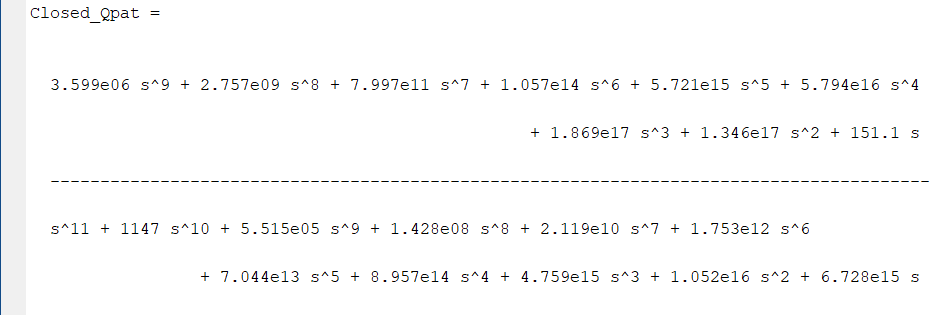
Closed\_Paw = (Ps(1)+(Cs\*Ps(1)))/(1+(Cs\*Ps(1)));

CLosed\_Qpat = (Ps(2)+(Cs\*Ps(2)))/(1+(Cs\*Ps(1)));

We found T1(s) to be:



And T2(s) to be:



**Task 3:**

Sketch the root locus of the control system shown in Fig. 4 for 0<ki< of the integral controller C(s).

Comparing equations 1 and 2 with,

And,

We Find that, for both closed loop transfer functions,

So, the root locus will be drawn for for

Code for plotting root locus:

clc;

clearvars;

s = tf('s');

Ps = [(1.799e04\*s+1.799e05)/(s^3+382.4\*s^2+3.758e04\*s+1.934e05);...

(3.599e06\*s+4.04e-09)/(s^3+382.4\*s^2+3.758e04\*s+1.934e05)];

figure(1)

rlocus(Ps(1)/s);

axis([-200 5 -205 205]);

Root Locus:

