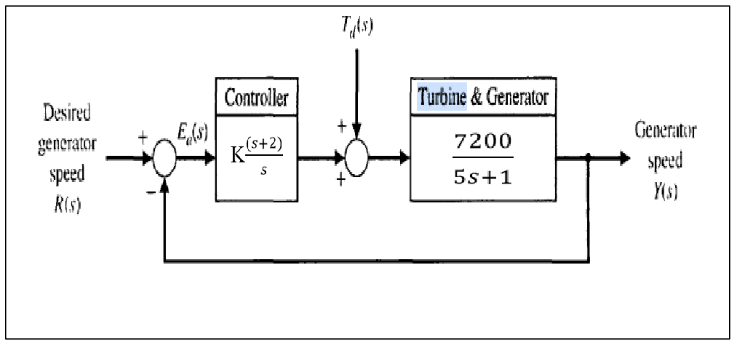
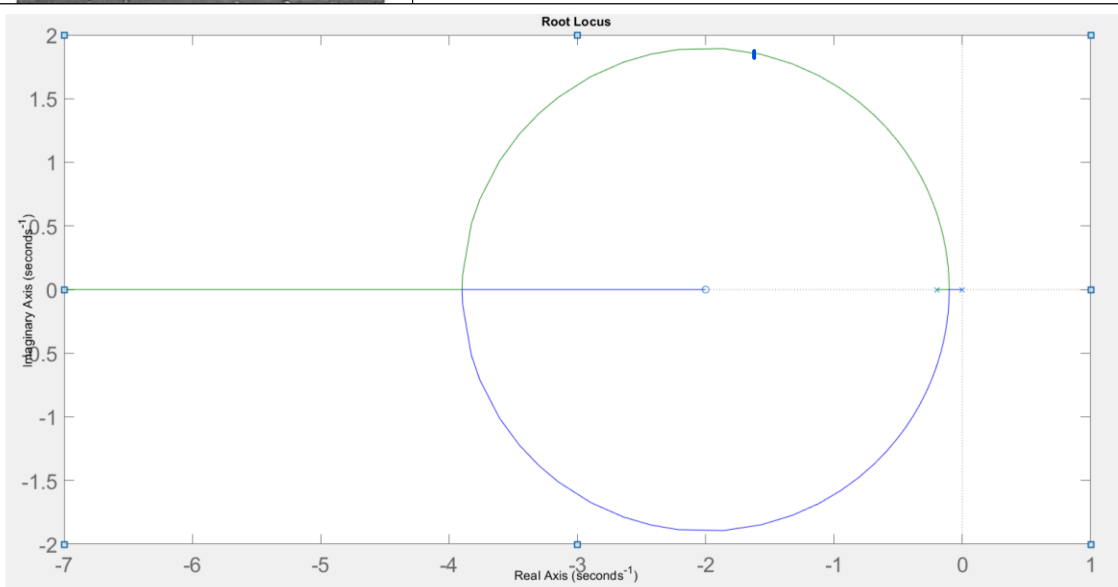
IE Dept School of Eng. UoJ Prof. M. Barghash MID Industrial Control systems 27/4/2023

Name: ID: Section:

Answer the following questions

Q1) **(ABET Question)** (5 points) Wind energy conversion to electric power is achieved by wind energy turbines connected to electric generators. Of particular interest are wind turbines, as shown in Figure below, that are located offshore. The new concept is to allow the wind turbine to float rather than positioning the structure on a tower tied deep into the ocean floor. This allows the wind turbine structure to be placed in deeper waters up to 100 miles offshore far enough not to burden the landscape with unsightly structures. Moreover, the wind is generally stronger on the open ocean potentially leading to the production of 5 MW versus the more typical 1.5 MW for wind turbines onshore. However, the irregular character of wind direction and power results in the need for reliable, steady electric energy by using control systems for the wind turbines. The goal of these control devices is to reduce the effects of wind intermittency and of wind direction change. The rotor and generator speed control can be achieved by adjusting the pitch angle of the blades.





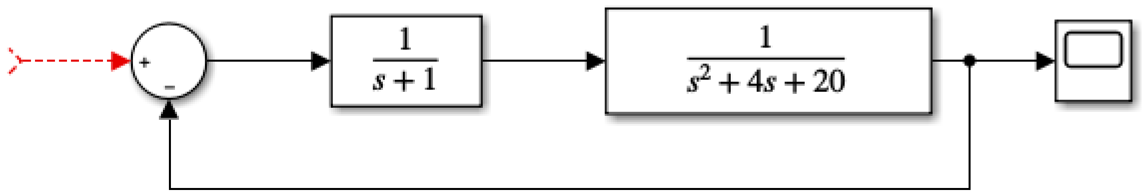
Design the value of K to achieve damping ratio of and 0.62 and settling time < 4

Solve here:

s=-1.6+2j

K= 1.97*10^-3.......

Q2 a) (2.5 points) Find the steady state error to a step input the following



Solution

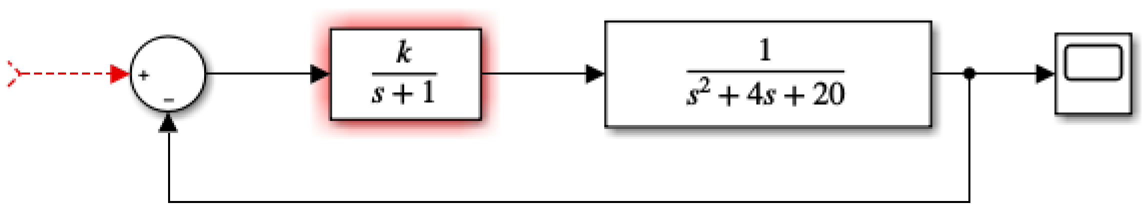
Ess=.0.9523...............................

b)(2.5 points) For the a part design add a controller to achieve steady state error = 1; when the input is 1/s^2.

Solution:

Controller =.........$\frac{20}{S}$.......................

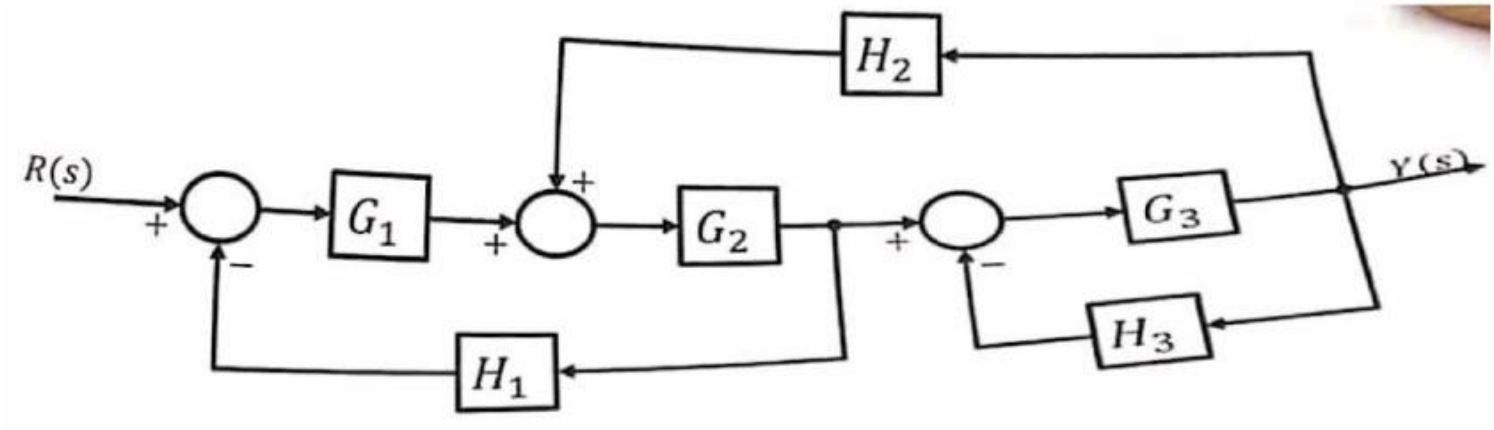
Q3(5 points) Use the Routh Hurwitz array to find the



Solution

K=.....0<K<100.....

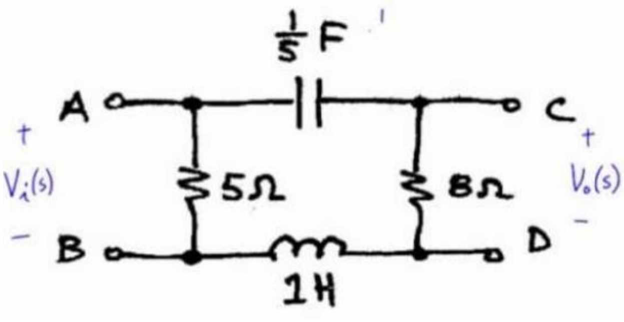
Q4) (5 points) find the equivalent transfer function for



Your answer

$$\frac{G1G2G3}{1+G1G2H1+G3H3-G2G3H2+G1G2G3H1H3}$$

Q5) Find the transfer function for (5 points)



(hint 1/5 F series with 8 ohm and 1 H) then all is parallel with 5 ohm)

Your answer

Vo ……= 8 / (8+5 + s … s)

Vi

$\frac{w}{s^2+w^2}$	------- sin(t)
$\frac{s}{s^2+w^2}$	------- cos(t)
$\frac{1}{s}$	--------- 1
$\frac{1}{s+a}$	---------e^{-at}

Q6) Find the response y(t) when

$$Y(s) = \frac{1}{(s+5)(s^2+4)}$$

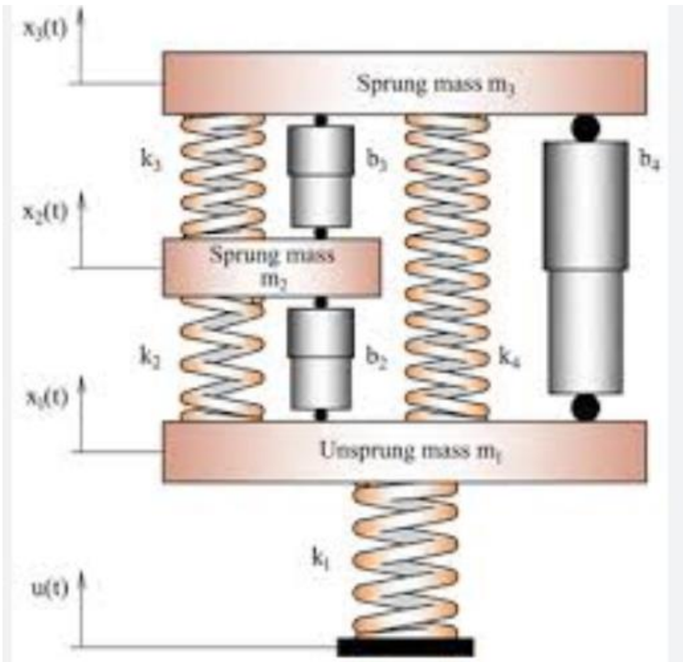
Yours answer

y(t)= e^-5t / 29 …….+ -1 / 29 ….. cos(2t)+0.086sin(2t)

Prof M. Barghash IE dept UoJ The university of Jordan Quiz 4

Name ID

Q1) Write the differential equations describing the following mechical systems u(t) is position same as x1 x2 and x3. Write the equations for m1, m2 and m3, b1,b2,b3 are dampers.



0=k1x1+k2(x1-x2)+b2(x1'-x2')+k3(x1-x3)+b3(x1'-x3')+mx1''

0=mx2''+k2(x2-x1)+b2(x2'-x1')+k4(x2-x3)+b4(x2'-x3')

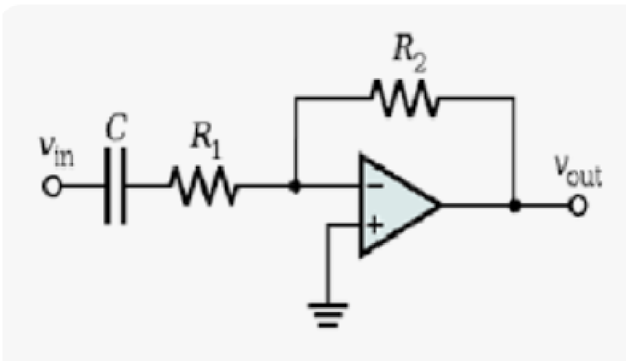
0=mx3''+k4(x3-x2)+b4(x3'-x2')+k3(x3-x1)+b3(x3'-x1')

Prof M. Barghash IE dept UoJ The university of Jordan Quiz 4

Name ID

Answer the following question

Q1) write the transfer function for



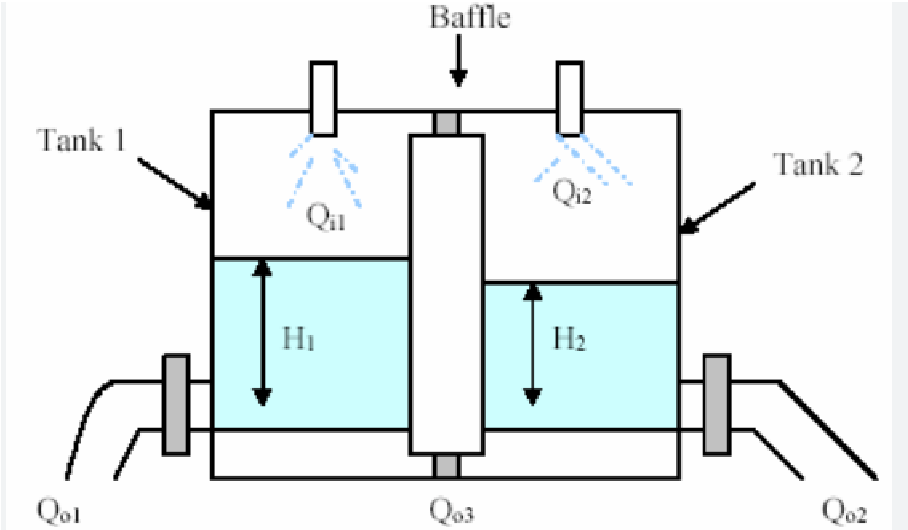
$$\frac{vo}{vi} = \frac{-R2}{R1+\frac{1}{CS}}$$

Prof M. Barghash IE dept UoJ The university of Jordan Quiz 4

Name ID

Answer the following question

Q1) write the differential equations describing the level system



XXXXX

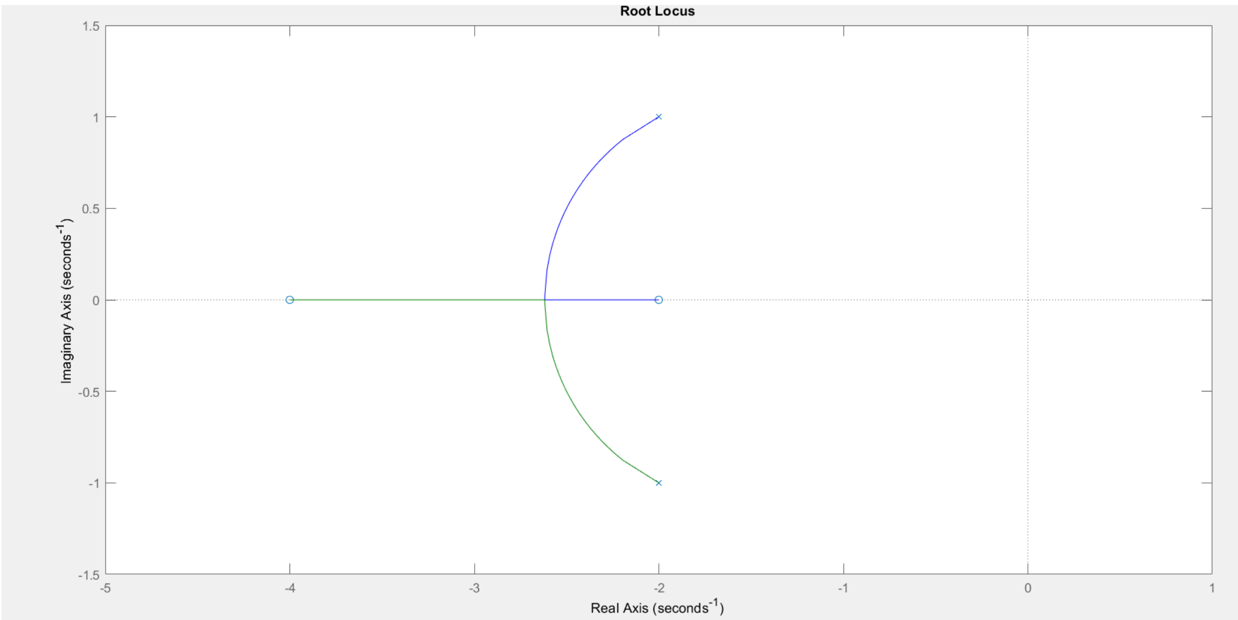
Make up Final exam Industrial control IE dept school of eng UoJ 28/2/2022 prof M. Barghash

Name: ID:

Q1) for the following root locus what is the gain to achieve percent overshoot of 0.1 and settling time of less than ~~1~~ (First deduct the control system notice that the root locus flows from the poles (crosses) to zeros(circles)) (10 points)

2

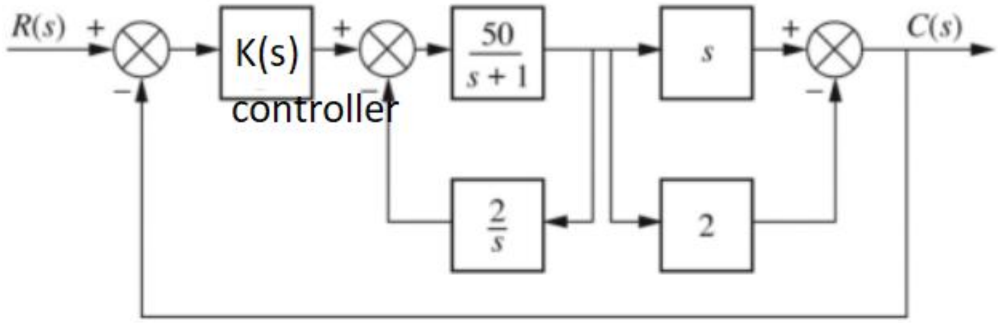
less than 0.1



Your answer

0<k<inf

Q2)for the following system design the steady state error for a step input to be zero and for a ramp input to be less than 2 (design the controller)? (note K(s) is any function of s to be suitably designed) (10 points)

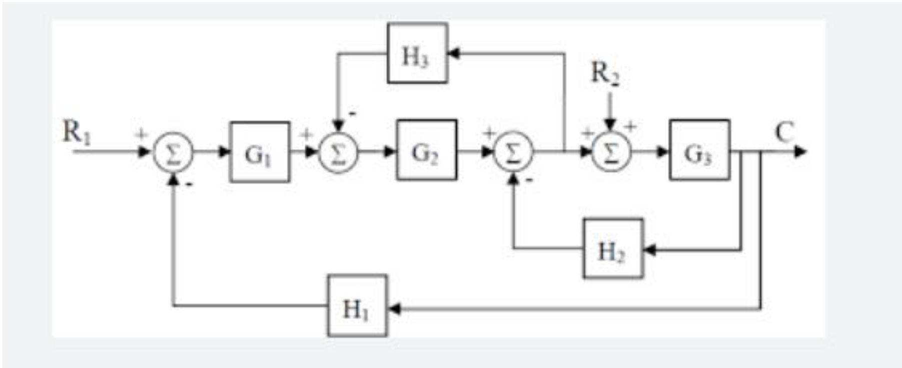


K
....
s^2

K>0

Q3) Reduce the following block diagram and find the transient response to a step input

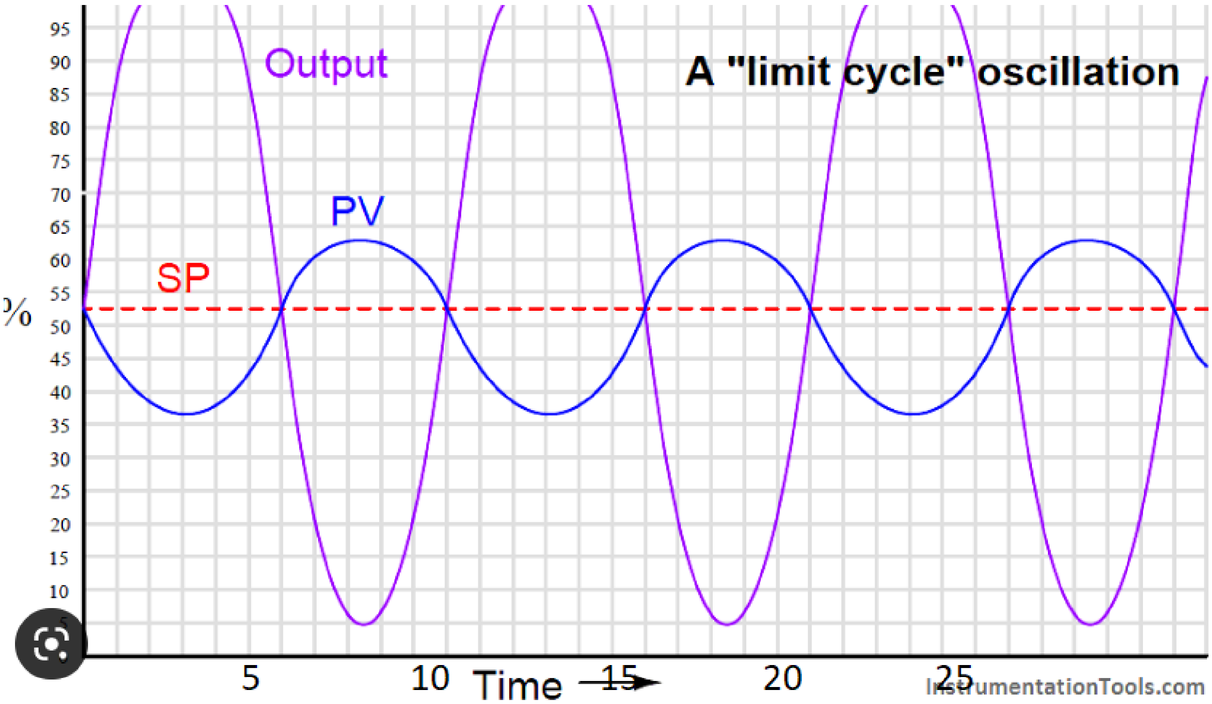
All G(s) are 1/(s+1) ; H2=H3= s; H1 =1 (R2 =0) R1=1/s. (10 points)



Your answer

XXXXX

Q4) Find the best PID using zigeler nichols oscillation method then implement the PID using either a code or operational amplifier and explain the values of the resistances and capacitances selected (10 points) The following results are achieved at gain =3 (SP set point) consider only the output curve.



	K_p	T_r	T_d
P	$0.50K_c$		
PI	$0.45K_c$	$\frac{P_c}{1.2}$	
PID	$0.60K_c$	$0.5P_c$	$\frac{P_c}{8}$

	K_p	T_r	T_d
P	$\frac{\nu_o}{K_o\tau_o}$		
PI	$\frac{0.9\nu_o}{K_o\tau_o}$	$3\tau_o$	
PID	$\frac{1.2\nu_o}{K_o\tau_o}$	$2\tau_o$	$0.5\tau_o$

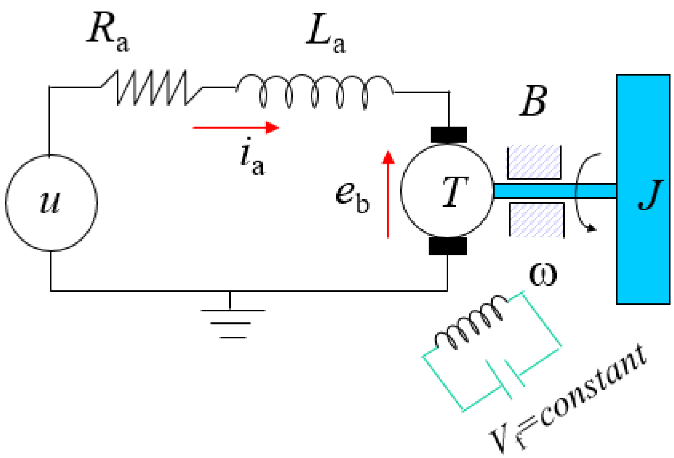
Your solution

Kp=1.8

Tr=5

Td=1.25

Q5) Figure below is a schematic for an armature controlled dc motor. Find the transfer function w/u where w is the rotational velocity and u is the voltage. (10 points)



in slides

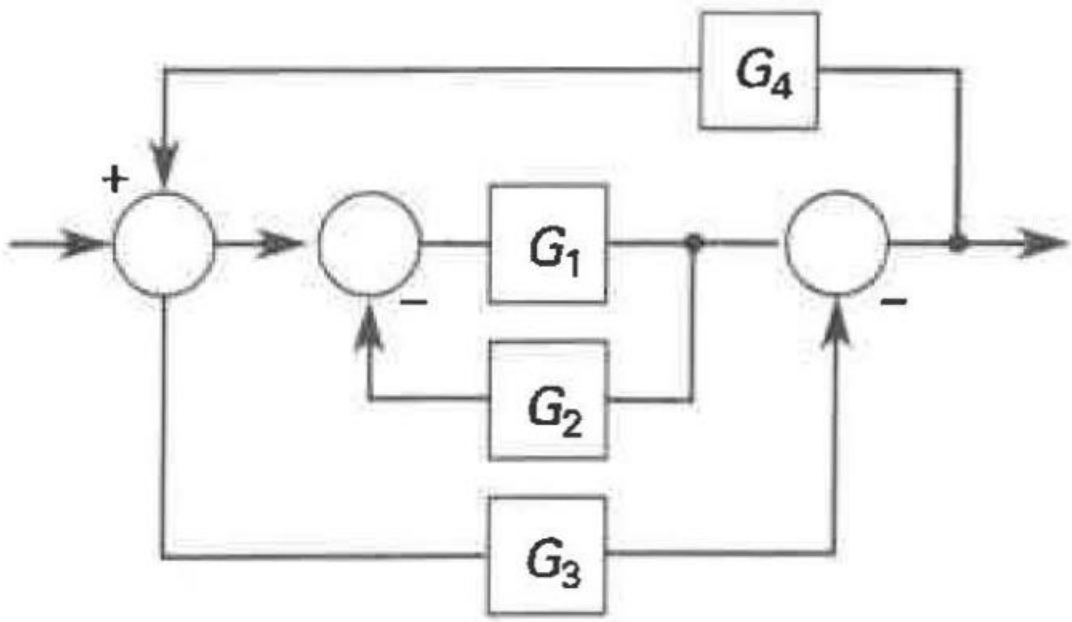
Q6)in the figure below

a)wire the TMP36 to the Arduino (3 points)

b) Write suitable code to read the TMP36 signal, convert it to temperature then send the result to the computer screen.

in slides

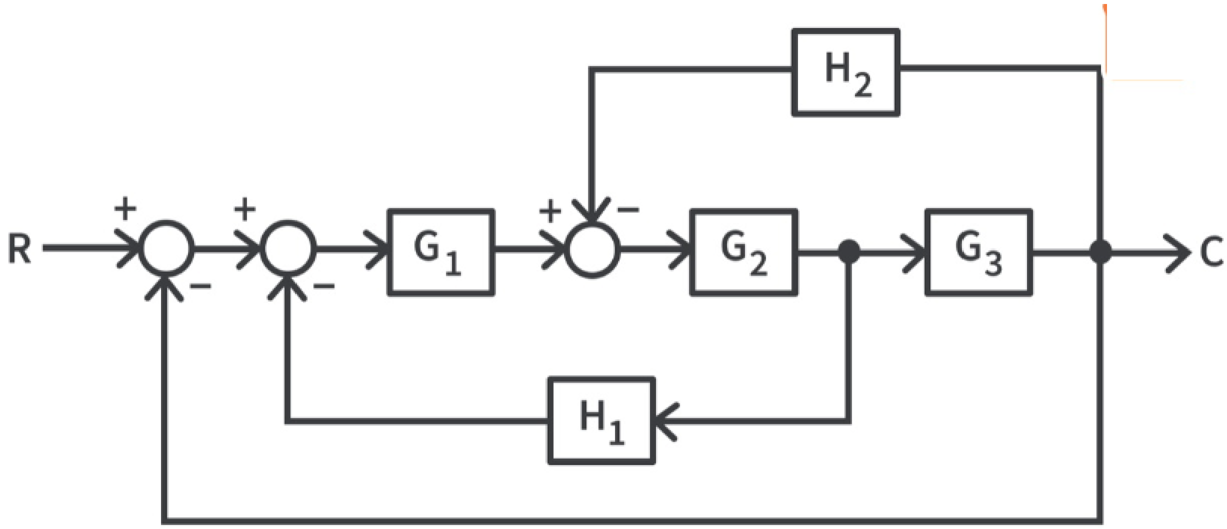
Find the equivalent transfer function for



'

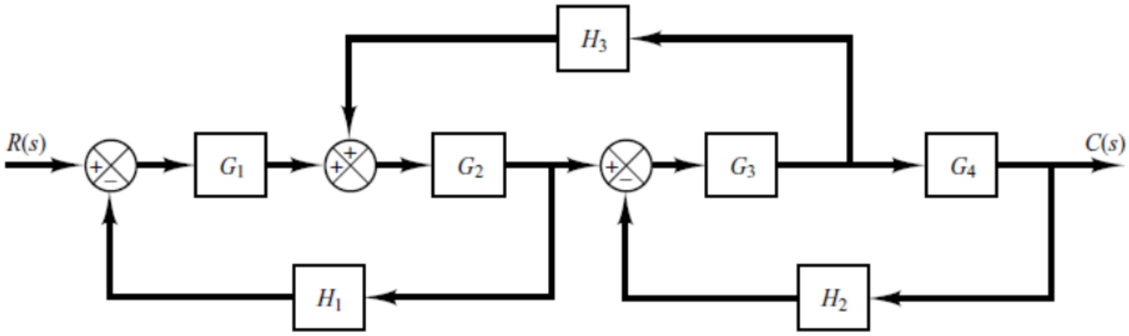
$$\frac{G1-G3-G1G2G3}{1+G1G2+G3G4-G1G4+G1G2G3G4}$$

Find the equivalent transfer function for



IN SLIDES

Find the equivalent transfer function for



$$\frac{G1G2G3G4}{1+G1G2H1+G3G4H2-G2G3H3+G1G2G3G4H1H2}$$

QUIZ 3 INDUSTRIAL CONTROL PROF M BARGHASH IE DEPT UoJ 9/4/2023

NAME: ID:

For the following system find the rise time, settling time and percent overshoot

$$\frac{c}{R} = \frac{s+3}{s^2+s+4.25}$$

Tr=0.91 SECOND
Ts =8 second
MP=45.58

QUIZ 3 INDUSTRIAL CONTROL PROF M BARGHASH IE DEPT UoJ 9/4/2023

NAME: ID:

For the following system find the rise time, settling time and percent overshoot

$$\frac{c}{R} = \frac{s+3}{s^2+4s+13}$$

Tr= 0.71 SECOND
Ts = 2 second
MP=12.64

QUIZ 3 INDUSTRIAL CONTROL PROF M BARGHASH IE DEPT UoJ 9/4/2023

NAME: ID:

For the following system find the rise time, settling time and percent overshoot

$$\frac{c}{R} = \frac{s+3}{s^2+9s+18}$$

first order system

Tr=0.3666

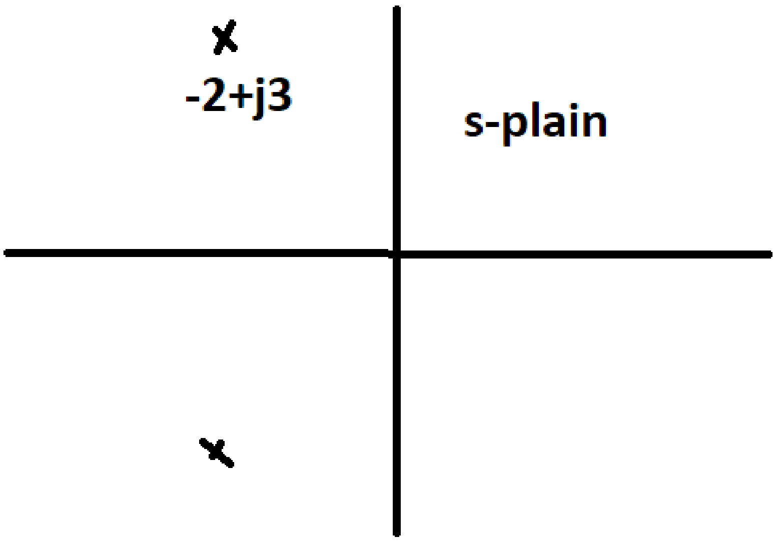
Ts=0.6666

mp=0

QUIZ 3 INDUSTRIAL CONTROL PROF M BARGHASH IE DEPT UoJ 9/4/2023

NAME: ID:

For the following system with roots shown in the following s-plane find the rise time, settling time and percent overshoot

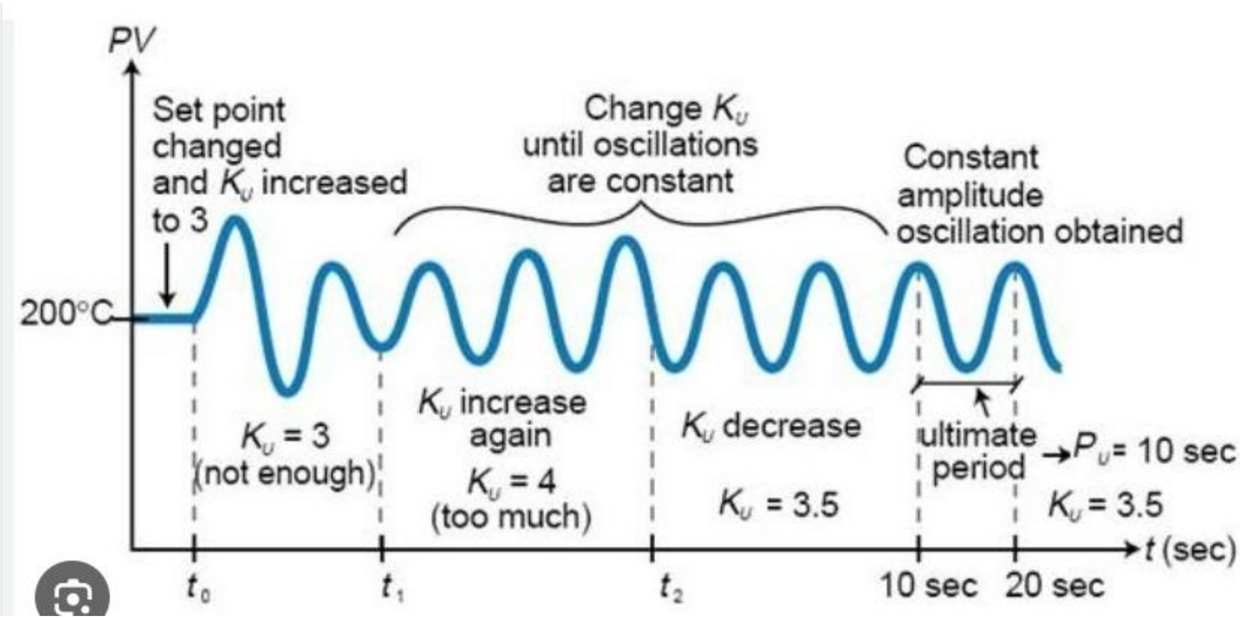


Tr=0.719 , Ts=2, Mp =12.3

Quiz Industrial control UoJ IE dept Prof M. Barghash21/5/2023

Name ID:

Q1)Design the PID controller using Zeigler Nichols Oscillation method



Solution

Table-2

Type of Controller	K_p	T_i	T_d
P	$0.5K_{cr}$	∞	0
PI	$0.45K_{cr}$	$\frac{1}{1.2}P_{cr}$	0
PID	$0.6K_{cr}$	$0.5P_{cr}$	$0.125P_{cr}$

32

Kp=2.1

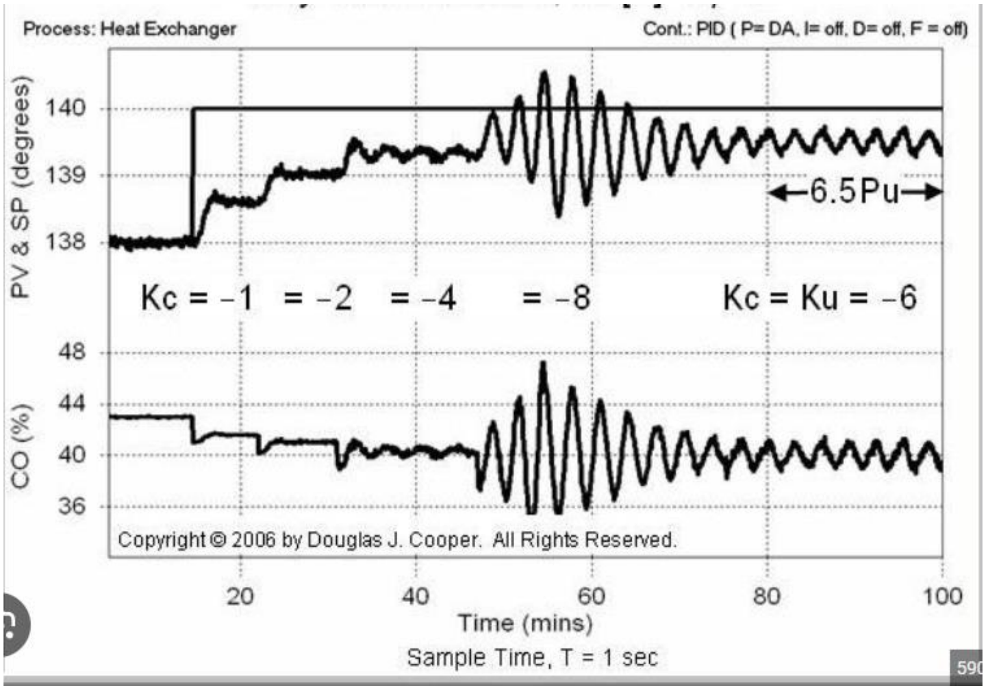
Ti=5

Td=1.25

Quiz Industrial control UoJ IE dept Prof M. Barghash21/5/2023

Name ID:

Q1)Design the PID controller using Zeigler Nichols Oscillation method



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P	$0.5K_{cr}$	∞	0
PI	$0.45K_{cr}$	$\frac{1}{1.2}P_{cr}$	0
PID	$0.6K_{cr}$	$0.5P_{cr}$	$0.125P_{cr}$ 32

Kp=3.6

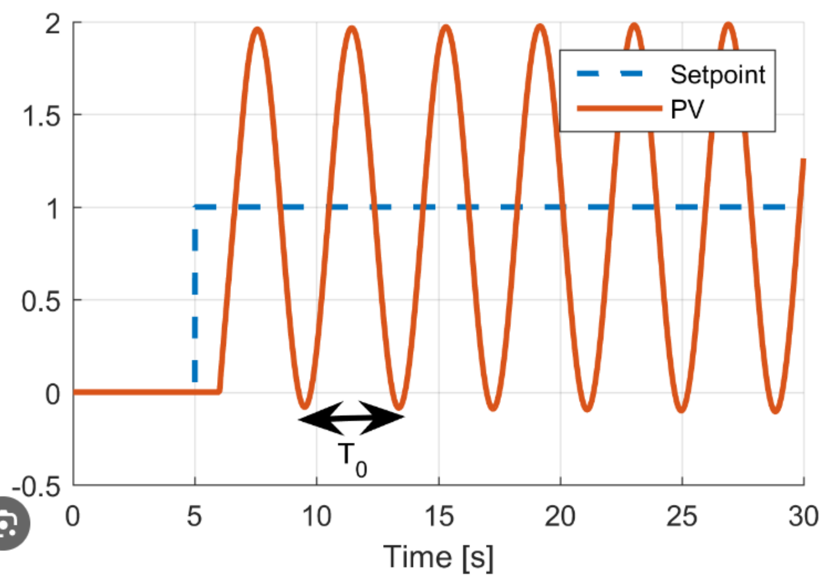
Ti=92.4

Td=23.1

Quiz Industrial control UoJ IE dept Prof M. Barghash21/5/2023

Name ID:

Q1)Design the PID controller using Zeigler Nichols Oscillation method



Solution

Table-2

Type of Controller	K_p	T_i	T_d
P	$0.5K_{cr}$	∞	0
PI	$0.45K_{cr}$	$\frac{1}{1.2}P_{cr}$	0
PID	$0.6K_{cr}$	$0.5P_{cr}$	$0.125P_{cr}$

32

The doctor forgot to put a value for K

ASSUME K =6

Kp=3.6

Ti=2

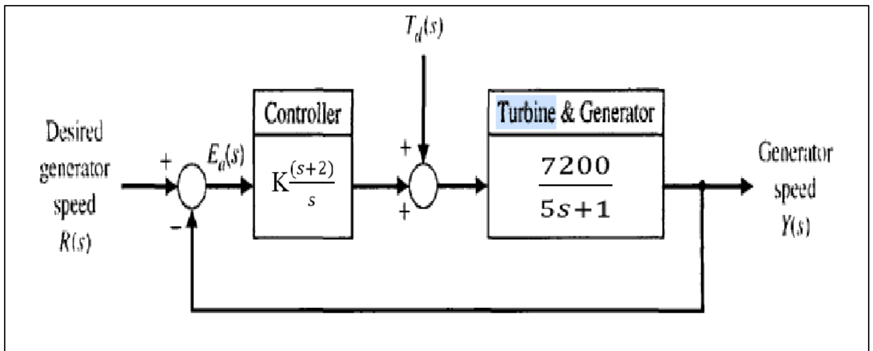
Td=0.5

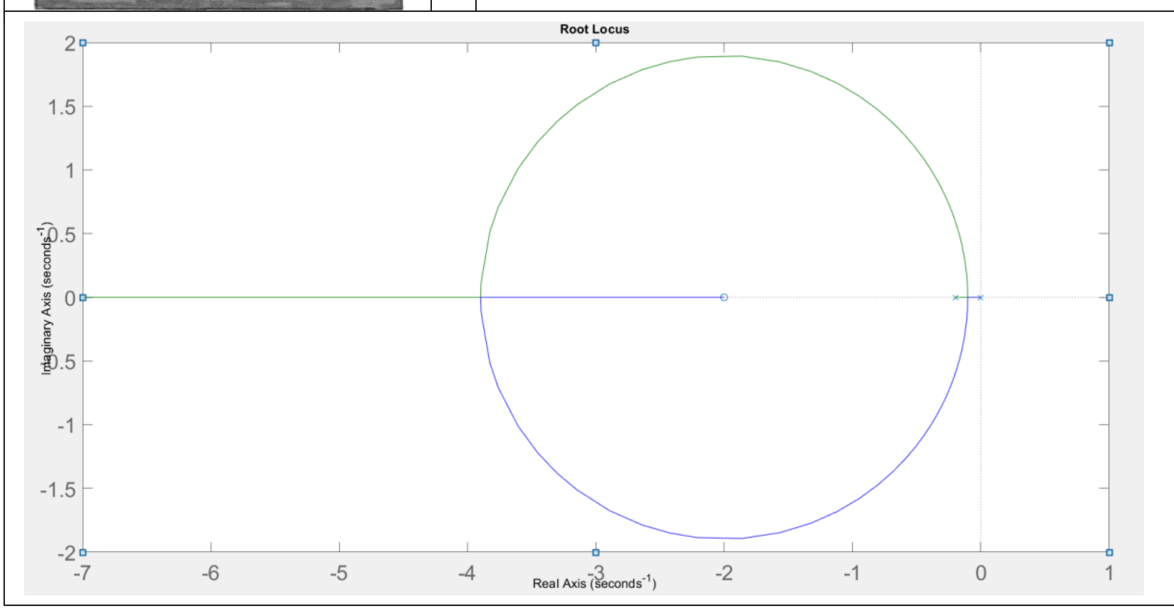
IE Dept School of Eng. UoJ Prof. M. Barghash MID Industrial Control systems 27/4/2023

Name: ID: Section:

Answer the following questions

Q1) **(ABET Question)** (5 points) Wind energy conversion to electric power is achieved by wind energy turbines connected to electric generators. Of particular interest are wind turbines, as shown in Figure below, that are located offshore. The new concept is to allow the wind turbine to float rather than positioning the structure on a tower tied deep into the ocean floor. This allows the wind turbine structure to be placed in deeper waters up to 100 miles offshore far enough not to burden the landscape with unsightly structures. Moreover, the wind is generally stronger on the open ocean potentially leading to the production of 5 MW versus the more typical 1.5 MW for wind turbines onshore. However, the irregular character of wind direction and power results in the need for reliable, steady electric energy by using control systems for the wind turbines. The goal of these control devices is to reduce the effects of wind intermittency and of wind direction change. The rotor and generator speed control can be achieved by adjusting the pitch angle of the blades.

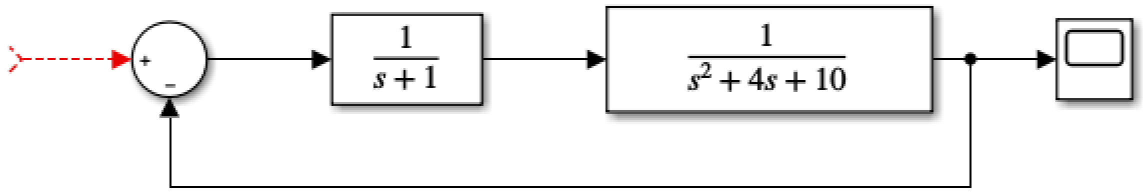




Design the value of K to achieve damping ratio of and 0.82 and settling tine < 4

Solve here:	
s=-2.5+1.8j	K= 3.33*10^-3 ....

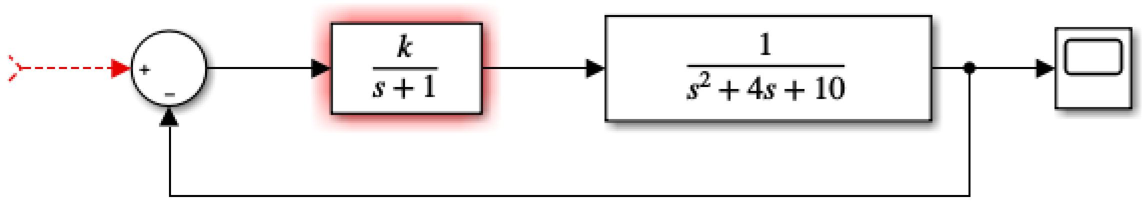
Q2 a) (5 points) Find the steady state error to a step input the following



Solution

Ess=......0.91..

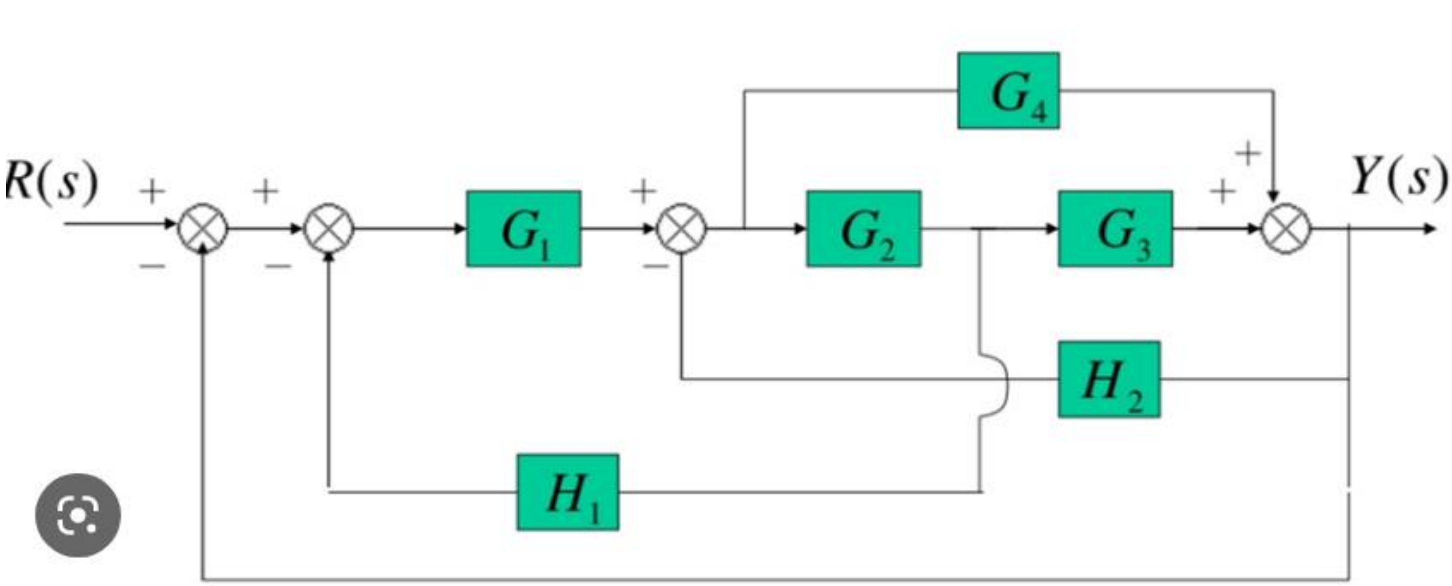
Q3(5 points) Use the Routh Hurwitz array to find the k for stability



Solution

K=....$0<K<60$.......................................

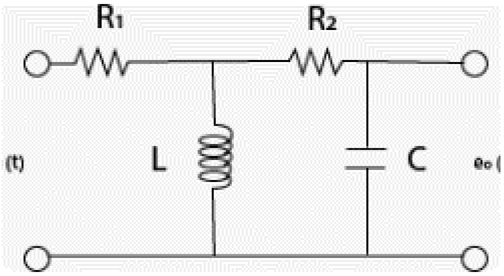
Q4) Find the equivalent transfer function for (5 points)



Your answer

$$\frac{G1G2G3+G1G4}{1+G1G2H1+G2G3H2+G1G2G3+G1G4+G4H2}$$

Q5) Find the transfer function for (5 points)



hint (R2 and C series) then parallel with L and all of them series with R1)

Your answer

Vo=i2
...
CS

i2(LS+R2+ 1)R1
....
CS

Vi= .... + i2(LS+R2+ 1) - i2LS
LS
....
CS

Q6) Find the response y(t) when

$$Y(s) = \frac{1}{(s+1)(s^2+2)}$$

$\frac{w}{s^2+w^2}$ ------- sin(t)

$\frac{s}{s^2+w^2}$ ------- cos(t)

$\frac{1}{s}$--------- 1

$\frac{1}{s+a}$---------e^{-at}

Yours answer

exp(-t)/3 - cos(2^(1/2)*t)/3 + (2^(1/2)*sin(2^(1/2)*t))/6