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**ECE 479/579 Digital Control Systems**

Homework Assignment #2

1. Write the Laplace transform of the following equations and then solve for x(t); the initial conditions are given to the right.

a) Dx + 8x = 0 x(0) = -2

b) D2x + 2.8Dx + 4x = 10 x(0) = 2, Dx(0) = 3

c) D2x + 4Dx + 3x = t x(0) = 0, Dx(0) = -2

d) D3x + 4D2x + 9Dx + 10x = sin 5t x(0) = -4, Dx(0) = 1, D2x(0) = 0

Because 

a)Sx-x(0)+8x=0

X(s)= -2/(s+8)

x(t)=-2\*exp(-8\*t)

b) X(s)= (3\*s+17.6)/(s^2+2.8\*s+4)

x(t)= 3\*exp(-(7\*t)/5)\*(cos((51^(1/2)\*t)/5) + (67\*51^(1/2)\*sin((51^(1/2)\*t)/5))/153)

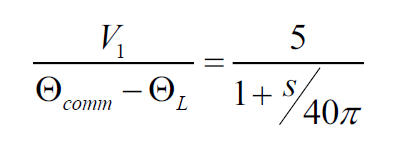
c) X(s)=(1/(s^2) – 2\*s)/(s^2 + 4\*s + 3)

x(t)= t/3 + (3\*exp(-t))/2 - (55\*exp(-3\*t))/18 - 4/9

d) X(s)= (5\*s + 5/(s^2 + 25) - 56)/(s^3 + 4\*s^2 + 9\*s + 10)

x(t)= (4\*cos(5\*t))/725 - (1909\*exp(-2\*t))/145 - (9\*sin(5\*t))/1450 + (329\*exp(-t)\*(cos(2\*t) - (407\*sin(2\*t))/1316))/25

2. A satellite-tracking system is shown in the accompanying schematic diagram. The transfer function of the tracking receiver is



The following parameters apply:

Ka = gain of servo amplifer = 60

Kt = tachometer constant = 0.04V\*s

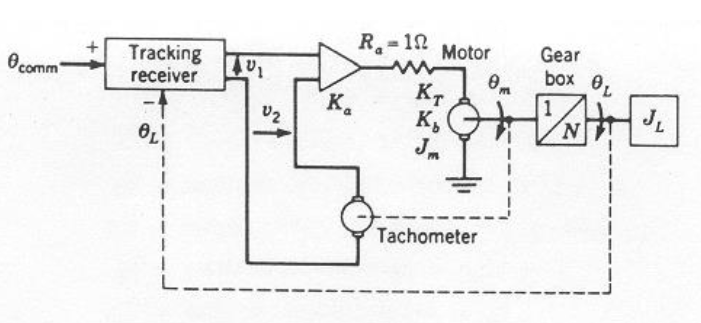
KT = motor torque constant = 0.5N\*m/A

Kb = motor back-emf constant = 0.75V\*s

JL = antenna inertia = 2880 kg\*m2

Jm = motor inertia = 7\*10-3 kg\*m2

1:N = gearbox stepdown ratio = 1:12000



a) Draw a detailed block diagram showing all the variables.

b) Derive the transfer function L(s) / comm(s).

e=(V1-V2)\*Ka

V2=Kt\*ωm

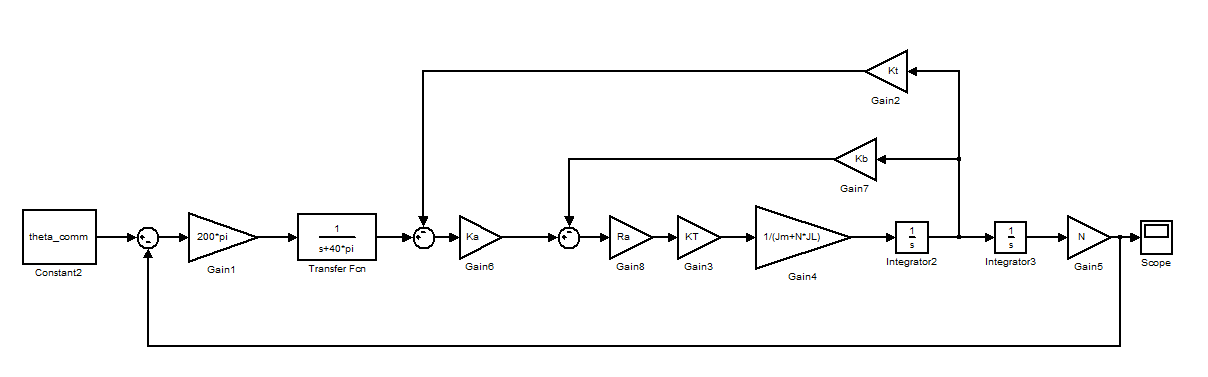
e=ia\*Ra+Kb\*ωm

T=KT\*ia

T=Jm\*dωm/dt+Tgear

Tgear=JL\*dωL/dt

ωL=N\*ωm



From inside loop to outside loop step by step: