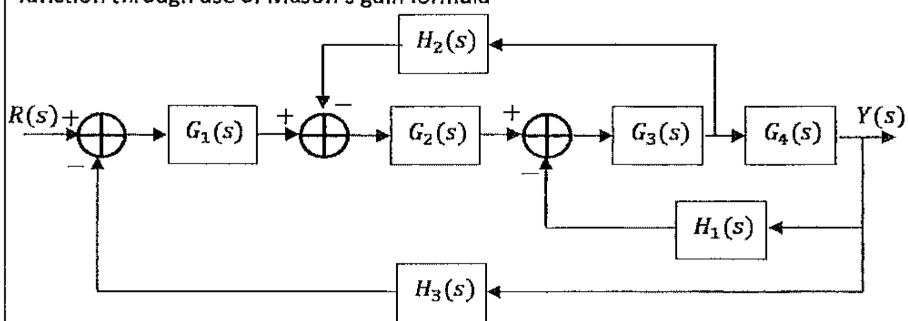
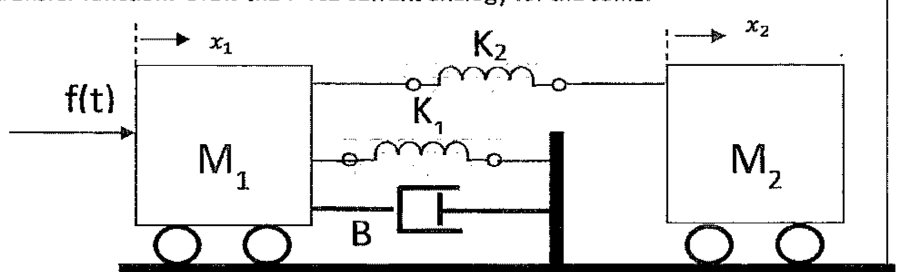
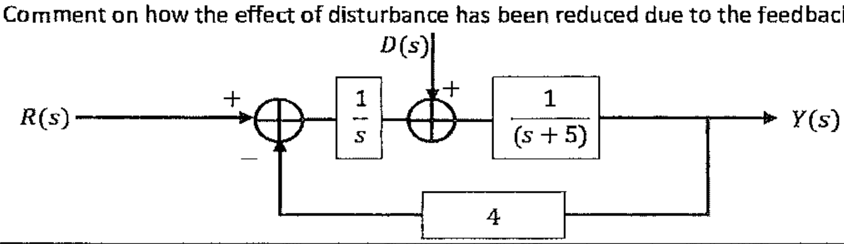
Revised.

SRN

PES University, Bangalore			
B Tech ESA 7TH SEMESTER – Dec 2017 **UE14EC403 Control Systems**			
Time: 3 Hrs		Answer All Questions	Max Marks: 100
Q1	a	Create a Signal Flow Graph for the block diagram given below and obtain the transfer function through use of Mason's gain formula  	10
	b	Draw the mechanical network for the mechanical system given below and derive the transfer function. Draw the force current analogy for the same.  	10
Q2	a	For the feedback control system shown below, find the transfer function due to the input and the disturbance. Assume superposition theorem. Find out $y(t)$ for unit step input and unit step disturbance and evaluate each at t=1 and t=4 seconds. Comment on how the effect of disturbance has been reduced due to the feedback.  	10

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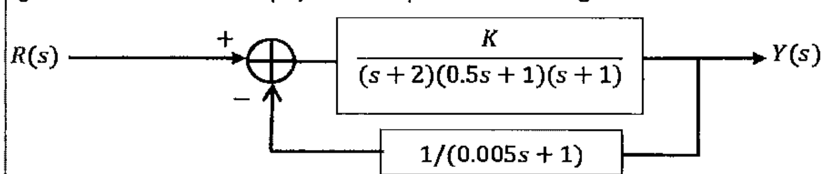
	b	The open loop transfer function of a unity feedback control system is as given below $$G(s) = \frac{K}{s(s+8)}$$ (i) Determine the steady state error coefficients K_p , K_v & K_a given K = 200. (ii) Determine steady state error e_{ss} when the input is $r(t) = 2t$. (iii) If the error is to be reduced by 5%, for the same ramp input, determine the new value of K. (iv) For K = 100 and unit step input, determine t_r, t_s and peak overshoot.	10
Q3	a	Sketch root locus for a control system whose open loop transfer function is given by $$G(s) = \frac{K}{s(s^2+36)}$$ Find out the range of K for stability. What are the intercepts of the root locus with the $j\omega$ axis ?	10
	b	Consider the block diagram of a control system given below. Determine K for stability given K > 0. What is the physical interpretation of a negative value of K? 	10
Q4	a	Draw the Bode plot for the control system with open loop transfer function given below for K=1. Determine gain and phase margins. What is the effect of increasing K on the gain and phase margins? $$G(s) = \frac{K}{s(s^2+5s+4)}$$	10
	b	Draw the Nyquist plot for an open loop transfer function given below assuming K = 1 $$G(s) = \frac{K(s+1)^2}{s(s-1)}$$ What should be the minimum value of K for stability.	10
Q5	a	Consider an open loop transfer function G(s) = $\frac{30}{s(s+2)(s+3)}$. What is the minimum e_{ss} achievable for a unit ramp function? Design a lag compensator for the system to ensuring $\phi_m = 40°$. Make necessary assumptions & approximations.	10
	b	The state equation and output equations are $\dot{X} = AX + BU$ and $Y = CX$ where $$A = \begin{bmatrix} -5 & 1 \\ -4 & 0 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix} \quad X(0) = \begin{bmatrix} 1 \\ 5 \end{bmatrix}$$ Evaluate the following (i) Transfer function (ii) State transition matrix (iii) Is the system controllable ? (iv) Is the system observable ?	10