SRN

PES University, Bangalore

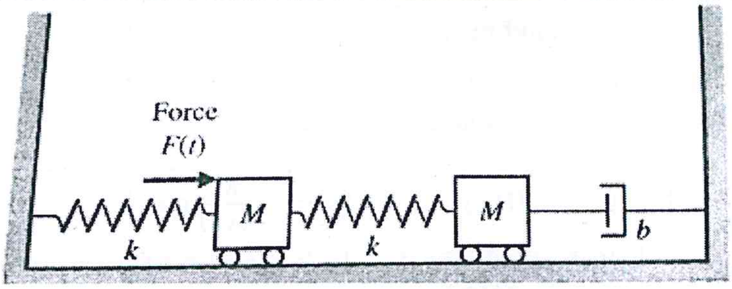
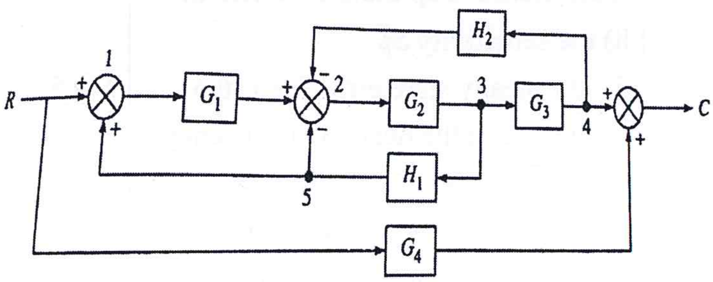
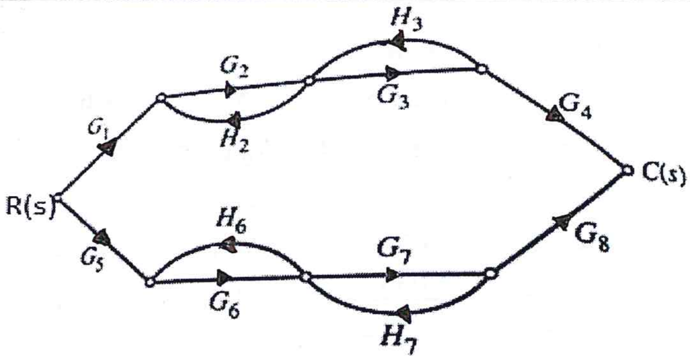
(Established under Karnataka Act No. 16 of 2013)

UE 17EC 251

END SEMESTER ASSESSMENT (ESA) - MAY 2019

B.TECH. IV SEMESTER **UE 17EC 251- CONTROL SYSTEMS**

Time: 3hrs **Answer All Questions** **Max Marks: 100**

Qn. No.		Question		Marks
1.	a)	A coupled spring-mass system is shown in Fig.1. Obtain the differential equations describing the mechanical system and hence draw the $f-i$ electrical analogous of the system.	 Fig.1	5
	b)	Simplify the block diagram shown in Fig.2 to open loop form.	 Fig.2	8
	c)	Determine the transfer function $C(s)/R(s)$ of the Signal flow graph shown in Fig.3	 Fig.3	7

<table>
<tr><th colspan="2">Qn. No.</th><th colspan="2">Question</th><th>Marks</th></tr>
<tr><td>2.</td><td>a)</td><td>The engine, body and tires of a racing car affect the acceleration and speed attainable. The speed control of the car is represented by the model shown in Fig.4. Find
i) the static error constants for a step command in speed.
ii) The steady state error of the car to a step command in speed.</td><td>

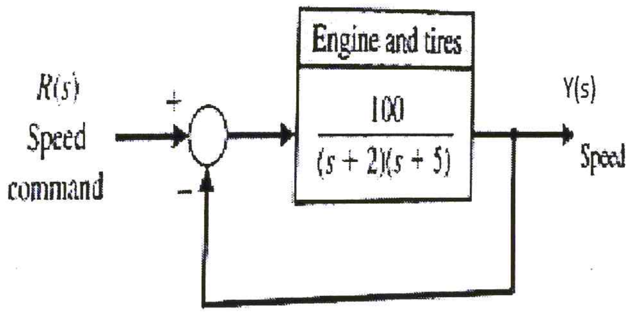


Fig.4</td><td>6</td></tr>
<tr><td></td><td>b)</td><td>If $H(s) = 1, Gc(s) = \frac{K}{10s+1}$ and $G(s) = \frac{1}{2s+1}$ in the block diagram of the system shown in Fig. 5 determine:-
i) the closed loop transfer function.
ii) the sensitivity S_K^T .
iii) the steady state error for a step change in the desired consistency if R(s)=A/s.
iv) the value of K required for an allowable steady state error of 2%.</td><td>

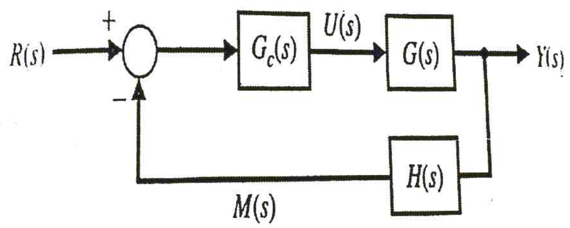


Fig.5</td><td>7</td></tr>
<tr><td></td><td>c)</td><td colspan="2">For the system shown in Fig.5, with $H(s) = 1, Gc(s) = \frac{1+sK_e}{s+2}$ and $G(s) = \frac{10}{s}$
determine:- i) the value of error rate K_e so that $\xi = 0.5$.
ii) the values of M_p and t_s with and without error rate control for a step input.
Comment on the effect of K_e on performance indices.</td><td>7</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>3.</td><td>a)</td><td colspan="2">Use R-H criterion to determine the values of K and a so that the UFB system with $G(s) = \frac{K\,(s+1)}{s^3 + as^2 + 2s + 1}$ oscillates at a frequency of $2rad/sec$.</td><td>10</td></tr>
<tr><td></td><td>b)</td><td colspan="2">The transfer function of a UFB systems is $G(s) = \frac{K\,(s+1)}{s(s+2)(s^2 + 2s + 2)}$. Sketch the direct root locus (Mark all the relevant points) to determine:-
i) range of stability ii) frequency of sustained oscillations iii) the critical value of K.</td><td>10</td></tr>
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<tr><th colspan="2">Qn. No.</th><th>Question</th><th>Marks</th></tr>
<tr><td>4.</td><td>a)</td><td>Investigate the stability of the negative feedback control system whose open loop transfer function is given by $GH(s) = \frac{50}{s(0.5s+1)(0.05s+1)}$. Use Bode plots. Find the following:
i) gain cross over frequency ii) phase cross over frequency
iii) gain margin iv) phase margin</td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Use Nyquist stability criterion to find the range of K for closed loop stability.
$G(s)H(s) = \frac{K(4s+1)}{s(s-1)}, K > 0$</td><td>10</td></tr>
<tr><td>5.</td><td>a)</td><td>A system has a transfer function $\frac{Y(s)}{U(s)} = G(s) = \frac{1}{(s+1)^2}$. Obtain the state model of the system.</td><td>4</td></tr>
<tr><td></td><td>b)</td><td>A single input, single output system is given by
$\dot{x}(t) = Ax(t) + Bu(t)$
$y(t) = Cx(t)$
where, $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 2 \end{bmatrix}$ and $C = [1 \quad 0]$
Compute the corresponding transfer function representation of the system. If the initial conditions are zero, determine the response $y(t)$ when the input to the system $u(t)$ is a unit step for $t \geq 0$.</td><td>5</td></tr>
<tr><td></td><td>c)</td><td>The state space representation of a system is given by
$\dot{x} = \begin{bmatrix} 2 & 0 \\ -1 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u$
$y = [1 \quad 1]x$
Determine whether the system is controllable and observable.</td><td>4</td></tr>
<tr><td></td><td>d)</td><td>The State variable model of a plant to be controlled is
$\dot{x} = \begin{bmatrix} -10 & 0 \\ 1 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$
$y = [0 \quad 1]x + [0]u$
Determine the state variable feedback gains to achieve a settling time (with a 2% criterion) of 1 second and an overshoot of about 10%.</td><td>7</td></tr>
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*** All the Best ***