| U.S.N. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

# B.M.S. College of Engineering, Bengaluru-560019

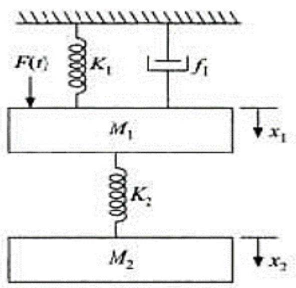
**Autonomous Institute Affiliated to VTU**

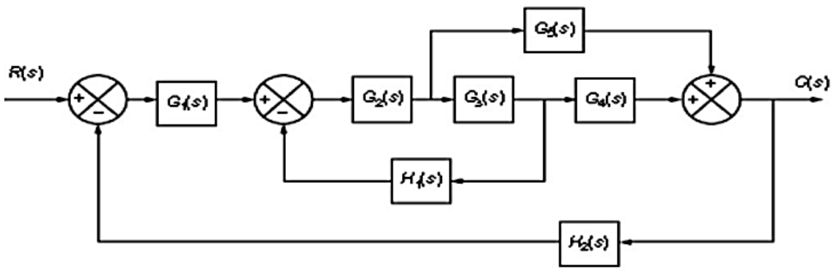
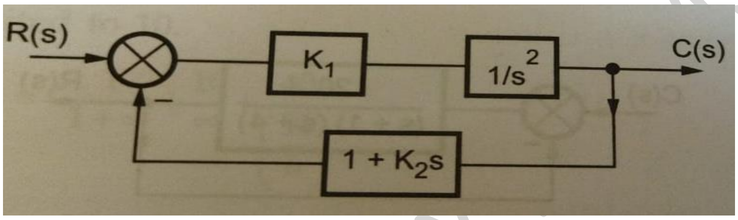
## September / October 2024 Supplementary Examinations

**Programme: B.E.** **Semester: IV**
**Branch: ES Cluster** **Duration: 3 hrs.**
**Course Code: 19ES4ESCST** **Max Marks: 100**
**Course: Control Systems**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | **UNIT - I** | *CO* | *PO* | **Marks** |
|---|---|---|---|---|---|
| 1 | a) | Distinguish open loop and closed loop control system with example. | *CO1* | *PO8, 9* | **08** |
| | b) | a) For the mechanical system shown in below fig, determine the following<br>i. Draw the mechanical network<br>ii. Obtain the equations of motions for masses $M_1$ and $M_2$<br><br>Obtain the F-V and F-I analogy<br><br> | *CO1* | *PO8, 9* | **12** |
| | | **OR** | | | |
| 2 | a) | For the system represented by the following equations, find the transfer function $X(s)/U(s)$ by the signal flow graph technique.<br>$x(t) = x_1(t) + \alpha_0 u(t)$<br>$dx_1/dt = -\alpha_1 x_1(t) + x_2(t) + \alpha_2 u(t)$<br>$dx_2/dt = -\alpha_2 x_1(t) + \alpha_1 u(t)$ | *CO1* | *PO8, 9* | **10** |
| | b) | Describe any two block diagram reduction rules with necessary diagrams. | *CO1* | *PO8, 9* | **04** |
| | c) | Apply the appropriate reduction rules and obtain the transfer function for the system shown in Fig. | *CO1* | *PO8, 9* | **06** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | |  | | | |
| | | **UNIT - II** | | | | |
| | 3 | a) | Define the time domain specifications of a second order system injected with a unit step input with diagram. | *CO2* | *PO8, 9* | **06** |
| | | b) | A unity feedback system is characterized by an open-loop transfer function G(s) = $\boldsymbol{K}/\ \boldsymbol{s}(\boldsymbol{s}+\mathbf{10})$. Determine the gain K so that the system will have a damping ration of 0.5. | *CO2* | *PO8, 9* | **06** |
| | | c) | For a control system shown in fig 3c, find the value of $K_1$ and $K_2$ so that $M_p$=25% and $T_p$=4 Sec. Assume unit step input.<br> | *CO2* | *PO8, 9* | **08** |
| | | **UNIT - III** | | | | |
| | 4 | a) | Investigate the stability of a closed loop system using RH criteria whose characteristic equation is given by $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. | *CO3* | *PO8, 9* | **08** |
| | | b) | Sketch the root locus plot for a closed loop system whose loop transfer function is given by,<br>G(s) H(s)= K/ s(s+4) (s+10)<br>Comment on stability. | *CO3* | *PO8, 9* | **12** |
| | | **UNIT - IV** | | | | |
| | 5 | a) | Define the frequency response specifications. | *CO4* | *PO8, 9* | **08** |
| | | b) | The open-loop transfer function of a system is given by,<br>G(s) H(s) = $\boldsymbol{K}\ /\boldsymbol{s}(1+s)\ (\mathbf{1}+\ \mathbf{0.1}\boldsymbol{s})$. Using Bode plot, find the value of K.<br>(i) GM = 10dB (ii) PM = $50^0$ | *CO4* | *PO8, 9* | **12** |
| | | **OR** | | | | |
| | 6 | a) | A negative feedback system is characterized by an open loop transfer function is G(s)H(s) = $\mathbf{1}\ /\boldsymbol{s}(\mathbf{1}+\boldsymbol{s})\ (\mathbf{0.5}+\boldsymbol{s})$. Sketch the polar plot and hence find the following<br>i. Gain cross over frequency<br>ii. Phase cross over frequency | *CO4* | *PO8, 9* | **10** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | iii. Gain margin<br>iv. Phase margin | | | |
| | | b) | The open-loop transfer function of a negative feedback control system is given by G(s) H(s) = K (s+3)/s($s^2$+2s+2)<br>Using Nyquist criteria, find the value of K for which the closed system is just stable. | *CO4* | *PO8, 9* | **10** |
| | | | **UNIT - V** | | | |
| | 7 | a) | Define State, state variables, and state space | *CO4* | *PO8, 9* | **06** |
| | | b) | Find the state transition matrix for A = $\begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$ | *CO4* | *PO8, 9* | **08** |
| | | c) | Consider the system given by,<br>$dy^3/dt^3+9\, dy^2/dt^2+26\, dy/dt+24y= 6u$<br>obtain its state model. | *CO4* | *PO8, 9* | **06** |

******