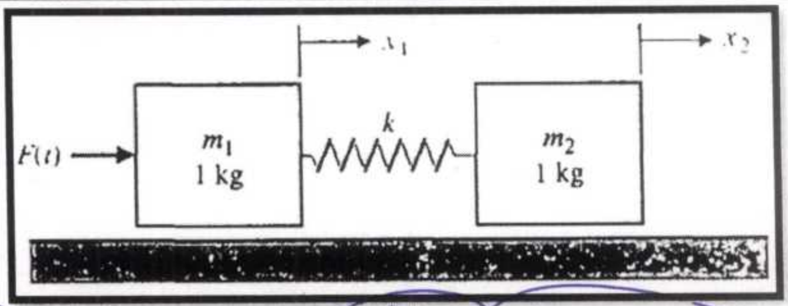
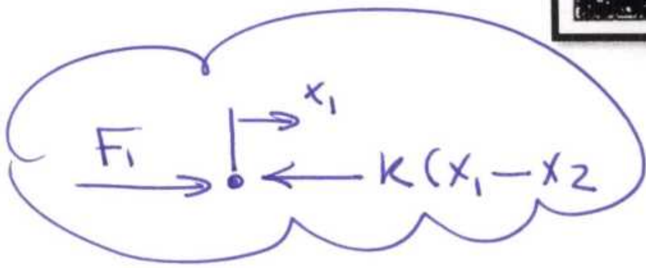
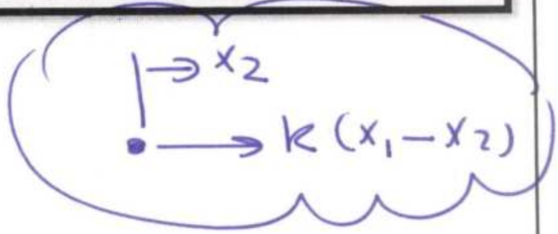
Mansoura University		Computer Engineering and Control Syst. Dept. Total Marks: 40 Marks	Faculty of Engineering
Course Title: **Control Engineering 1**			Course Code: **CSE 3116**
Date: 26 Nov. 2015		Allowed time: 1 hr.	No. of Pages: (02)
Remarks: (Answer the following questions… assume any missing data)			

Question No. (1) (10 Marks)

1. Determine the transfer function $X_2(s)/F(s)$ for the system shown in Figure below. Both masses slide on a frictionless surface, and $k = 1$ N/m. Draw the Block diagram







$$F - k(x_1 - x_2) = m_1 s^2 X_1$$

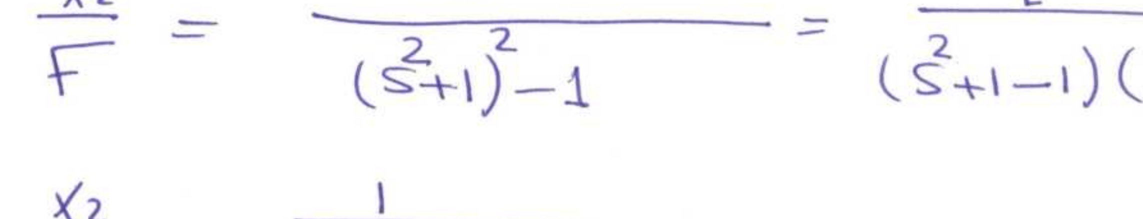
$$\boxed{F + kX_2 = (m_1 s^2 + k)X_1}$$

$$F + X_2 = (s^2+1)X_1$$

$$k(x_1 - x_2) = m_2 s^2 X_2$$

$$kx_1 = (m_2 s^2 + k)X_2$$

$$X_1 = (s^2+1)X_2$$

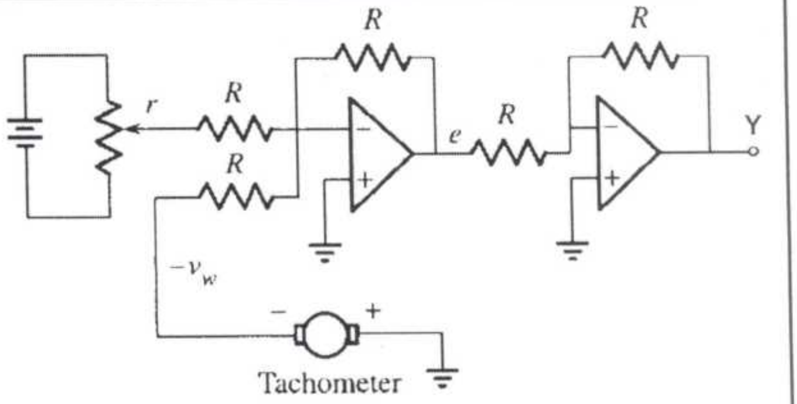


$$\frac{X_2}{F} = \frac{1}{(s^2+1)^2 - 1} = \frac{1}{(s^2+1-1)(s^2+1+1)}$$

$$\frac{X_2}{F} = \frac{1}{s^2(s^2+2)}$$

Question No. (2) (10 Marks)

Obtain the equation that relates the output voltage $\mathbf{Y}(s)$ to $\mathbf{r}(s)$ and $v_w(s)$



1st op-AMP

$$\frac{r}{R} - \frac{V_w}{R} = \frac{-e}{R}$$

$$e = -(r - V_w)$$

2nd op-AMP

$$\frac{e}{R} = \frac{-Y}{R}$$

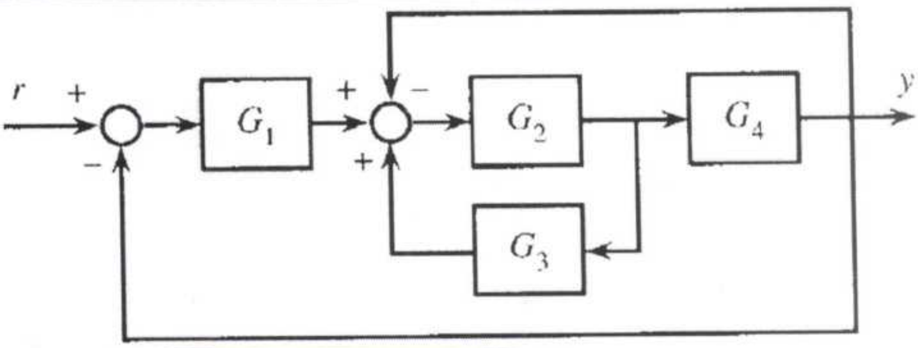
$$Y = -e$$

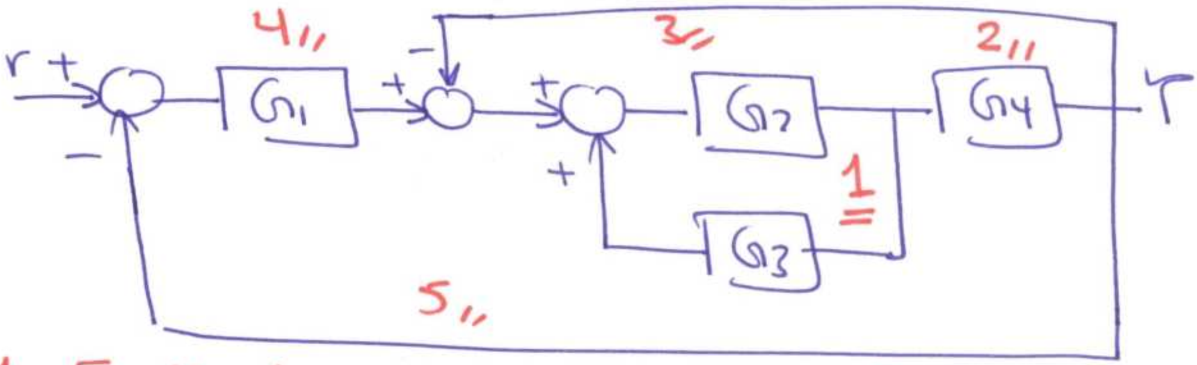
$$\therefore Y = -\left(-[+r - V_w]\right)$$

$$Y = r - V_w$$

Question No. (3) (10 Marks)

Use block manipulation to find the transfer function from r to y





1- Feedback 2. Series 3. Feedback 4. Series
5. Feedback

$$\frac{Y}{R} = \frac{G_4 G_2 G_1}{1 - G_2 G_3 + G_2 G_4 + G_1 G_2 G_4}$$

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Question No. (4) (10 Marks)

Obtain the unit-step response of the following system:

$$\frac{C(s)}{R(s)} = \frac{10}{s^2 + 4s + 12}$$

$$r(t) = 1 \Rightarrow R(s) = 1/s$$

$$C(s) = \frac{10}{s(s^2+4s+12)}$$

$$= \frac{10/12}{s} + \frac{As+B}{s^2+4s+12}$$

$$10 = \frac{10}{12}(s^2+4s+12) + s(As+B)$$

Coefficient of $s^2 = 0 = \frac{10}{12} + A \quad A \Rightarrow \frac{-10}{12}$

" of $s = 0 = \frac{10}{3} + B \quad B = \frac{-10}{3}$

$$\therefore C(s) = \frac{10/12}{s} - \frac{10}{12} \frac{s+4}{s^2+4s+12}$$

$$C(s) = \frac{10/12}{s} - \frac{10}{12} \frac{(s+2)+2}{(s+2)^2+8}$$

$$C(s) = \frac{10/12}{s} - \frac{10}{12}\left[\frac{s+2}{(s+2)^2+8} + \frac{2}{\sqrt{8}} \frac{\sqrt{8}}{(s+2)^2+8}\right]$$

$$c(t) = \frac{10}{12} - \frac{10}{12} e^{-2t}\left(\cos\sqrt{8}t + \frac{1}{\sqrt{2}} \sin\sqrt{8}t\right)$$