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# P.E.S. College of Engineering, Mandya - 571 401

***(An Autonomous Institution affiliated to VTU, Belgaum)***

**Fifth Semester, B.E. - Electrical and Electronics Engineering**

**Semester End Examination; Dec - 2016/Jan - 2017**

**Linear Automatic Control Systems**

*Time: 3 hrs* *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
*ii) Missing data, if any, may suitably assume.*

**UNIT - I**

1 a. What is analogy? What is its need in Control System Engineering? 4

b. For the mechanical system shown in Fig.1(b), obtain transfer function $\theta_1(s)/T(s)$ 6

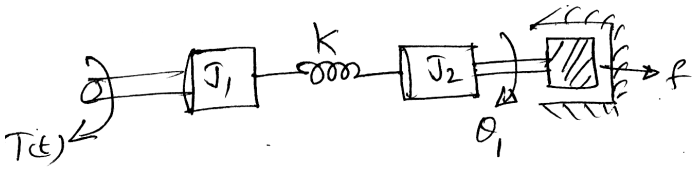



fig 1.b.

c. For the mechanical system shown in Fig. 1c, obtain force-voltage analogous circuit, 10

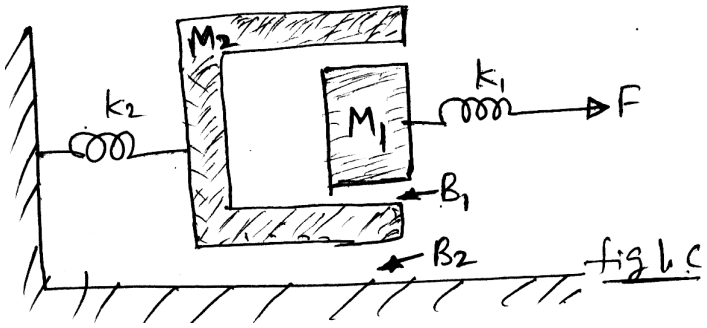



fig 1.c

2 a. For the system shown in Fig. 2a, Obtain transfer functions by block diagram reduction technique and verify the result by signal flow graph method. 12

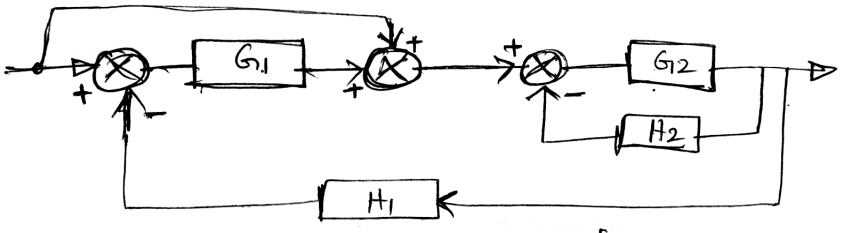



fig 2.a.

b. A linear system is described by the following equations. Write signal flow graph and hence obtain transfer function $x_4/x_1$ of the system, 8

$x_2 = G_1x_1+x_3G_3$, $x_3 = G_2x_2+x_1G_4+G_5$ $x_4 = x_3G_7+x_2G_6$

Contd….2

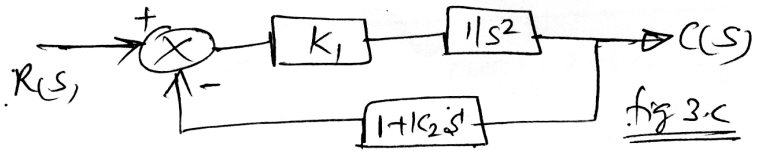
## UNIT - II

3 a. Define Rise time, Peak overshoot and Settling time for a second order system. 6

b. Find $t_r$, $t_s$ and $M_p$ of UFB system whose open loop transfer function is given by, 6

$$G(S)=\frac{36}{S(S+6)}.$$

c. For a control system shown in Fig. 3c, find values of $K_1$ and $K_2$, $M_p$ = 25% and Tp = 4 sec. Assume unit step input. 8




4 a. What is steady state error? Derive expression of $e_{SS}$ for a closed loop system. 6

b. A unity feedback system with loop transfer function is given by $G(S)=\frac{10(S+1)}{S(S+2)(S+5)}$. 8

Determine error constants and steady state error when input is 3+10t.

c. Explain the effect of adding poles to open loop and closed loop-transfer function. 6

## UNIT - III

5 a. Explain Routh Hurwitz stability criterion. What are necessary and sufficient conditions for stability? 10

b. The open loop transfer function of a unity feedback control is given by $G(S)=\frac{K}{(S+2)(S+4)(S^2+6S+25)}$. Determine the value of *K* which will cause sustained oscillations in the closed-loop system. What are the corresponding oscillating frequencies? 10

6 a. What is root-locus? Explain the procedure steps to construct root-locus of given open loop transfer function. 10

b. Sketch the complete root-locus of the UFB system whose open loop transfer function is, $\frac{K}{S(S^2+6S+10)}$. 10

## UNIT - IV

7 a. Define the frequency domain specifications:

(i) Resonant Peak (ii) Cut-off rate 6

(iii) Gain margin (iv) Phase-Margin (v) Band width.

b. The damping ratio and natural frequency of oscillation of a second order system is 0.5 and 8 rad/sec respectively. Calculate the resonant peak and resonant frequency. 2

Contd….3

c. Draw Bode plots for the following transfer function hence find stability, gain margin and phase margin, 12

$$G(S)=\frac{60(1+0.5S)}{(1+0.1S)(1+2S)(1+0.02S)}$$

8 a. What is frequency response? What are the advantages of frequency response analysis? 8

b. Draw Bode plots for the following transfer function, 12

$$G(S)=\frac{K}{S(1+0.1S)(1+S)}$$

(i) Find GM and PM (ii) Find value of *K* for just stable

(iii) Find value of *K* for a gain margin of 10 db.

**UNIT - V**

9 a. Explain how to obtain GM and PM from polar plots? 6

b. Sketch the polar plot of following transfer functions, 4

(i) $G(S)=\frac{1}{1+ST}$ (ii) $G(S)=\frac{1}{S^2(1+ST_1)(1+ST_2)(1+ST_3)}$.

c. Draw the polar plot of the following transfer function, hence obtain GM and PM 10

$$G(S)=\frac{1}{S^2(1+S)(1+2S)}.$$

10 a. What is Nyquist Stability criterion? Explain the procedure for investigating stability using Nyquist criterion. 12

b. Sketch the Nyquist plot for the system with the open loop transfer function 8

$G(S)H(S)=\frac{5}{S(1-S)}$. Determine stability.

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