Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐

R 3338

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Fourth Semester

Mechatronics Engineering

EE 1264 — CONTROL SYSTEMS

(Regulation 2004)

Polar, Semilog graph sheets are to be provided.

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   What are basic elements of translational and rotational mechanical system?

2.   State Mason's gain formula.

3.   Mention any four time-domain specifications.

4.   What is meant by steady-state error?

5.   Define : Phase margin.

6.   What is meant by all pass system?

7.   How is stability related to location of roots in s-domain?

8.   How is Nyquist stability criterion used to determine closed loop stability of systems?

9.   What is meant by compensation?

10. How is time-domain specifications converted into a pair of dominant root locations?

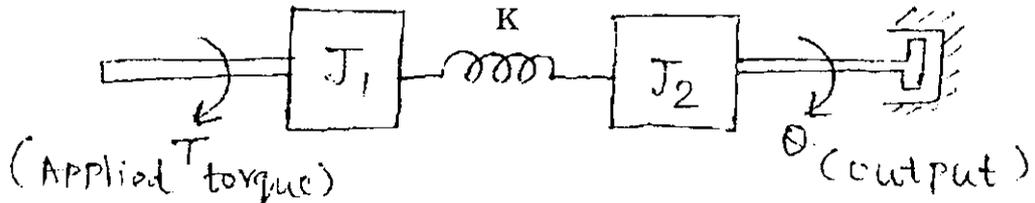11. (a) Obtain the transfer function of the following mechanical system (figure 1).

Figure 1   Qn. 11 (a)

Or

(b) For the system represented by the following equations, find the transfer function $X(s)/U(s)$ by signal flow graph technique.

$$x = x_1 + \beta_3 u$$
$$\dot{x}_1 = -a_1 x_1 + x_2 + \beta_2 u$$
$$\dot{x}_2 = -a_2 x_1 + \beta_1 u$$

12. (a) Figure 2 shows a system employing proportional plus error-rate control. Determine the value of the error-rate factor Ke so that the damping ratio is 0.5. Determine the values of settling time, maximum overshoot and steady-state error (for unit ramp input) with and without error-rate control. Comment upon the effect of error-rate control on system dynamics.
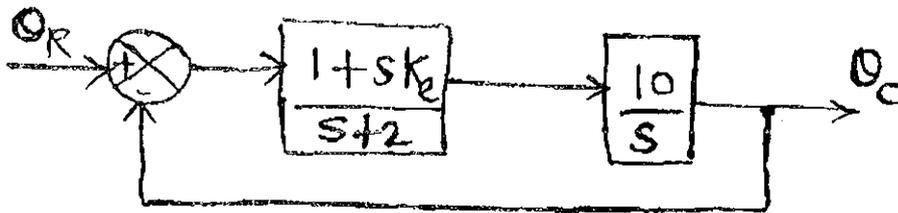

Figure 2   Qn. 12 (a)

Or

(b) A unity feedback system is characterized by the open-loop transfer function $G(S) = \dfrac{10}{S(0.1S+1)}$. Determine the steady state errors for unit-step, unit-ramp, and unit-acceleration input. Also evaluate the dynamic error of the system when subjected to an input given by the polynomial $r(t) = a_0 + a_1 t + \dfrac{a_2}{2} t^2$.

13. (a) Sketch the Bode plot for the following transfer function and determine gain margin & phase margin $G(S) = \dfrac{10}{S(1+0.5S)(1+0.1S)}$.
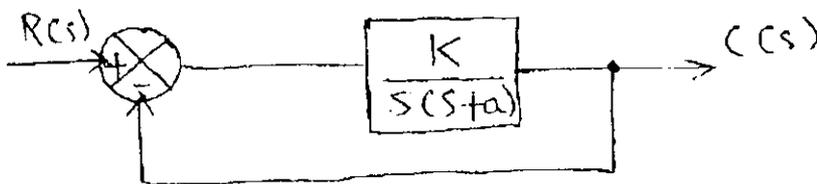
Or

(b) Consider the feedback system shown in figure 3.

Figure 3   Qn. 13 (b)

   (i) Find the value of 'K' and 'a' to satisfy the following frequency domain specifications $Mr = 1.04$ and $\omega r = 11.55$ rad/sec

   (ii) For the values of 'K,' and 'a' determined in part (i), calculate the settling time and bandwidth of the system.

14. (a) A unity feedback control system is characterized by the open-loop transfer function $G(S) = \dfrac{K(S+13)}{S(S+3)(S+3)}$

   (i) Using the Routh criterion, calculate the range of values of K for the system to be stable.

   (ii) Check if for $K = 1$, all the roots of the characteristic equation of the above system have damping factor greater than 1.

Or

(b) Draw the root-locus plot for the following open-loop transfer function

$$G(S) = \dfrac{K}{S(S+4)(S^2+4S+20)}.$$

15. (a) Write the steps involved in lead compensator design using frequency domain approach

Or

(b) Write the steps involved in lag compensator design using time domain approach