Reg. No. : | | | | | | | | | | | |

D 4205

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2008.

Fourth Semester

(Regulation 2004)

Electrical and Electronics Engineering

IC 1251 – CONTROL SYSTEMS

(Common to Instrumentation and Control Engineering)

(Common to B.E. (Part-Time) Third Semester Regulation 2005)

Time : Three hours — Maximum : 100 marks

Semilog sheets will be provided on demand.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define Transfer function.

2. State Mason's Gain Formula.

3. List time domain specifications.

4. Draw the time response of a first order system subjected to unit step input.

5. Write the expressions for constant M and N circles.

6. Represent the bandwidth ω_b in terms of time domain parameters ω_n and ζ.

7. Define gain margin and phase margin.

8. State Nyquist stability criterion.

9. State the need of compensators in control system design.

10. Draw the Bode plot of a phase lag compensator.

PART B — (5 × 16 = 80 marks)

11. (a) Draw the block diagram representation of the network shown in fig. 11.(a) and determine its transfer function. Verify your results with Mason's gain formula.

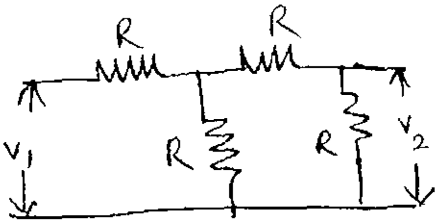

Fig. 11.(a)

Or

(b) For the mechanical system shown in fig.11.(b) draw the electrical equivalent network using force to voltage analogy. Also, determine its transfer function.

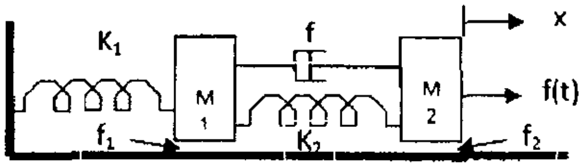

Fig.11.(b)

12. (a) (i) Derive an expression for the time response of an under damped second order system subjected to unit step input. (8)

(ii) A unity feedback system is characterized by the open-loop transfer function G(s) = 1/(s (0.5 s + 1)(0.2 s + 1)). Determine the steady state errors for unit-step, unit-ramp and unit-acceleration inputs.(8)

Or

(b) (i) For the feedback system shown in Fig.12.(b).

(1) Determine the damping factor and natural frequency of the system when $K_0 = 0$. What is the steady state error resulting from unit ramp input. (4)

(2) Determine the derivative feedback constant K_0 which will increase the damping factor of the system to 0.6. What is the steady state error to unit-ramp input with this setting? (2)

(3) How the steady state error of the system with derivative feedback to unit ramp can be reduced to same value as in part (a), while the damping factor is maintained at 0.6. (2)

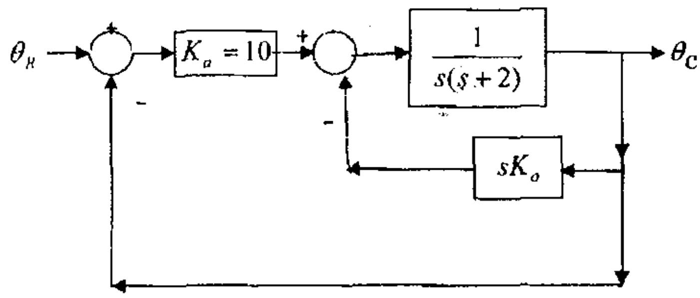

Fig. 12.(b)

(ii) State the effects of P,I and D controllers on the system dynamics.(8)

13. (a) (i) Using Nichols chart plot the closed-loop frequency response of a system whose open-loop transfer function is

$$G(s) = \frac{10}{s(0.1s+1)(0.05s+1)}.$$

(ii) Derive an expression for resonant peak in terms of damping factor ζ.

Or

(b) (i) Sketch the Bode plot for a unity feedback system, characterized by the open-loop transfer function

$$G(s) = \frac{K(1+0.2s)(1+0.025s)}{s^2(1+0.001s)(1+0.005s)}$$

Show that the system is conditionally stable. Find the range of values of K for which the system is stable.

(ii) Derive an expression for constant M circles of a closed-loop system.

14. (a) Draw the root-locus of a system characterized by open-loop transfer function

$$G(s) = \frac{K(s+1)(s+2)}{(s+0.1)(s-0.1)}$$

Find from the root-locus plot the value of K for which a closed-loop system is critically damped.

Or

(b) Sketch the Nyquist plot for a system with open-loop transfer function $G(s)H(s) = \frac{K(1+0.5s)(s+1)}{(1+10s)(s-1)}$

Determine the range of values of K for which the system is stable.

15. (a) (i) Draw the schematic electrical network of a lag network and deduce its transfer function.

(ii) For a type-I unity feedback system with an open-loop transfer function.

$G_f(s) = \frac{K_v}{s(s+1)}$ design a phase lead network so that the compensated system will have velocity error coefficient $(K_v) = 12\,\text{sec}^{-1}$ and a phase margin $(\varphi_{pm}) = 40^{\circ}$.

Or

(b) (i) Derive an expression for the frequency ω_m, at which the phase angle of a lead network is maximum.

(ii) Design a lag network for a system with open-loop transfer function $G(s) = \frac{K}{s(s+1)(s+4)}$ so that the compensated system will have a damping ratio $\zeta = 0.4$, settling time t_s = 10 sec and velocity error constant $K_v \geq 5\,\text{sec}^{-1}$.

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