Register Number....................

B.E. DEGREE EXAMINATIONS: APRIL / MAY 2009

Fourth Semester

MECHATRONICS ENGINEERING

U07MH404 Control Systems

Time: Three Hours

Maximum Marks: 100

(Graph Sheets, Semi Log Sheets and Polar Graph Sheets are to be provided)

Answer ALL the Questions:-

PART A (20 x 1 = 20 Marks)

1. Which of the following is an open loop system?

    A. Electric switch   B. Human Being   C. Liquid level control system   D.CNC Machine

2. Feedback control systems are

    A. band-pass filters   B. low-pass filters   C. high-pass filters   D.band-reject filters

3. To which of the following systems, the transfer function is applicable?

    A. Linear and time-variant systems   B. Linear systems
    C. Linear and time-invariant systems   D. Non-linear systems

4. Signal flow graph is a

    A. special type of graph for analysis of modern control systems
    B. semilog graph
    C. log-log graph
    D. topological representation of a set of differential equations

5. The characteristic equation of a second order system is given by $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$. The condition for critical damping is

    A. $\zeta = 0$ B. $\zeta = 1$ C. $\zeta < 1$ D. $\zeta > 1$

6. The transfer function of a system is $\dfrac{10}{1+s}$. The steady state error to unit step input when operated with a unity feedback system is ---------------------------.

    A. 10   B. 0   C. $\dfrac{1}{11}$ D. $\dfrac{1}{10}$

7. Velocity error constant of a system is measured when the input to the system is unit ----------------- function.

    A. step   B. ramp   C. parabolic   D. impulse

8. Introduction of integral action

    A. changes a system from type I to II   B. changes a system from type II to I C.
    changes a system from type I to 0   D. has no change in its type

9. The damping ratio and natural frequency of a second order system are 0.4 and 10 rad/sec respectively. The resonant frequency is

    A. 4.246 rad/sec   B. 6.246 rad/sec   C. 8.246 rad/sec   D. 2.246 rad/sec

10. The function $\left(\dfrac{1}{j\omega t} \right)$ has slope of

    A. + 20 db/decade   B. – 20 db/decade   C. + 40 db/decade   D. – 40 db/decade

11. The frequency at which two asymptotes meet is known as

    A. Critical frequency   B. Threshold frequency
    C. Cut-off frequency   D. Corner frequency

12. A system is stable when its

    A. Gain Margin and Phase Margin are positive
    B. Gain Margin and Phase Margin are negative
    C. Gain Margin is negative and Phase Margin is positive
    D. Gain Margin is positive and Phase Margin is negative

13. The characteristic equation of a system has roots with negative real parts if and only if elements of the first column of the Routh's table have

    A. same sign   B. positive sign
    C. negative sign   D. alternative positive and negative signs

14. A system with characteristic equation $(s + 1)(s + 2)(s - 3) = 0$ is

    A. marginally stable   B. stable   C. unstable   D. not necessarily stable

15. Which of the following are the starting points for root loci?

    A. Open loop zeros   B. Closed loop zeros   C. Open loop poles D. Closed loop poles

16. ----------------- is used for Nyquist plot.

    A. Characteristic equation   B. Open loop function
    C. Closed loop function   D. Either (B) or (C)

17. A lag compensation network normally consists of

    A. R and L elements   B. L and C elements
    C. R and C elements   D. R, L and C elements

18. The dominating poles are

    A. the poles which are very close to $j\omega$ axis in the s-plane

    B. the poles which are very far from $j\omega$ axis in the s-plane

    C. the poles which are on the real axis in the s-plane

    D. the poles which are very far from real axis in the s-plane

19. Phase ----------- compensator increases the bandwidth most.

    A. Lag   B.lead   C.lag-lead   D.both (A) and (B)

20. In cascade compensation, the compensating network is introduced ------------- path of the system.

    A. in forward   B. in feedback
    C. one in forward and another one in feedback   D. in either forward or feedback

21. (a) Write the differential equation governing the mechanical system shown in Fig.21(a) and determine the transfer function $\dfrac{X_2(s)}{F(s)}$.
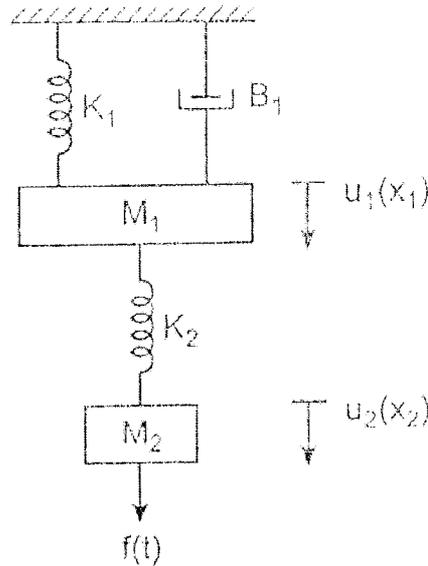

Fig.21 (a)

21. (b) Explain the rules for block diagram reduction and hence find the overall transfer function $\dfrac{C(s)}{R(s)}$ for the block diagram shown in Fig. 21(b).
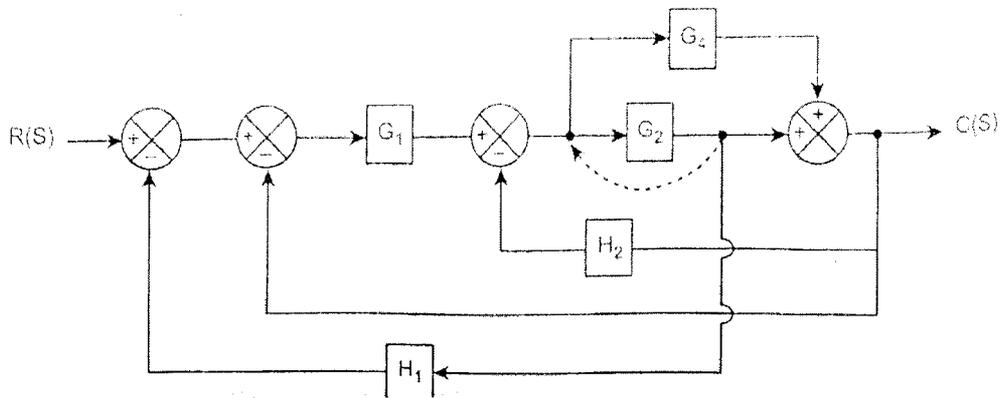

Fig.21 (b)

22. (a) Determine the time domain specifications and expression for output for unit step input to a system governed by the following differential equation:

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 16y = 9x.$$ Assume zero initial conditions.

(OR)

(b) (i) Derive the expression for steady state error of the closed loop system in terms of generalized error coefficients. (8)

(ii) Discuss the functioning of P, PI and PID controllers with necessary diagrams. (8)

22. (a) Sketch the Bode plot for the open loop transfer function

$$G(s) = \frac{5}{s(1+0.2s)(1+0.02s)}$$ and determine

(i) Gain cross over frequency   (ii) Phase cross over frequency. Assume H(s) = 1.

(OR)

23. (b) For an example of your choice, describe the procedure to draw Polar plot and determine the gain margin and phase margin.

24. (a) (i) State and explain Routh Hurwitz Criterion for stability. (6)

(ii) Construct Routh array for the system represented by the characteristic equation $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$. Comment on the stability of the system. (10)

(OR)

24. (b) Sketch the root locus for the open loop transfer function of unity feedback control system given below:

$$G(s)H(s) = \frac{K}{s(s+2)(s+4)}$$

25. (a) Design a suitable lead compensator for a unity feedback system whose open loop transfer function is given by $G(s) = \frac{K}{s(s+8)}$, so that the static velocity error constant $K_v \geq 100$ sec^{-1} and the phase margin is $\geq 55°$.

(OR)

25. (b) (i) Describe the design procedure of phase lag compensation using root locus technique. (12)

(ii) Write MATLAB command to find the gain margin and phase margin of the following system using Bode plot: (4)

$$G(s) = \frac{1}{s^3 + 2s^2 + 5s + 2}$$

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