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Register Number:……………………..
B.E DEGREE EXAMINATIONS: NOV/DEC 2014
(Regulation 2009)
Sixth Semester
ELECTRONICS AND COMMUNICATION ENGINEERING
ECE117: Control Systems Engineering

Time: Three Hours   **Maximum Marks: 100**
**Answer all the Questions:-**
PART A (10 x 1 = 10 Marks)

1. In a closed loop control system, with positive value of feedback gain the overall gain of the system will
   a) decrease
   b) increase
   c) be unaffected
   d) depend on the input of the system

2. A.C. servomotor resembles
   a) two phase induction motor
   b) three phase induction motor
   c) direct current series motor
   d) Universal motor

3. For a type one system, the steady – state error due to step input is equal to
   a) infinite
   b) zero
   c) 0.25
   d) 0.5

4. By which of the following the system response can be tested better?
   a) Ramp input signal
   b) Sinusoidal input signal
   c) Unit impulse input signal
   d) Exponentially decaying signal

5. An increase in gain, in most systems, leads to
   a) smaller damping ratio
   b) larger damping ratio
   c) constant damping ratio
   d) does not affect damping ratio

6. A system with gain margin close to unity or a phase margin close to zero is
   a) highly stable
   b) oscillatory
   c) relatively stable
   d) unstable

7. The equation $2s^4 + s^3 + 3s^2 + 5s + 10 = 0$ has _____ roots in the left half of s-plane.
   a) one
   b) two
   c) three
   d) four

8. Which of the following is the best method for determining the stability and transient response?
   a) Root locus
   b) Bode plot
   c) Nyquist plot
   d) Polar plot

9. Addition of zeros in transfer function causes which of the following?
   a) Lead-compensation
   b) Lag-compensation
   c) Lead-lag compensation
   d) does not affect the system

10. A phase lag-lead network introduces in the output
    a) lag at all frequencies
    b) lag at high frequencies and lead at low frequencies
    c) lag at low frequencies and lead at high frequencies
    d) lead at all frequencies

PART B (10 x 2 = 20 Marks)

11. For the system whose signal flow graph is shown by Fig.1, find R(s)/ Y(s).
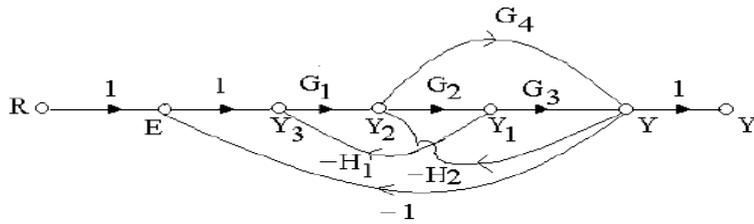
12. A thermostatically controlled furnace automatically regulates the temperature of an enclosure. The input to this system is a reference temperature, specified by setting a thermostat. The output is the actual temperature of the enclosure. Draw the block diagram for this control system.

13. The unit-impulse response of a system starting from rest is given by $C(t) = 1 - e^{-2t}$ for $t \geq 0$. Find the transfer function.

14. In the control system shown below, $G(s) = 9/s$ and H has the form $H = (As + B)/s$. What type of controller is $H(s)$.
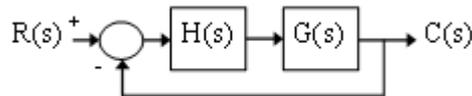
15. Find the damping ratio of a system having the characteristic equation, $s^2 + 2s + 8 = 0$.

16. Consider the closed-loop system given by

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{\left(s^2 + 2\xi\omega_n s + \omega_n^2\right)}$$

Determine the values of ζ and ω_n so that the system responds to a step input with approximately 5% overshoot and with a settling time of 2 seconds.

17. A certain system has the open-loop transfer function

$$GH = K(s+2) / s(s+6)^2$$

As K varies the roots of the system have N loci. Find N. As K tends to infinity M loci tend to infinity. Find M

18. Draw the general shapes of the polar plots of type 0, type 1, and type 2 systems.
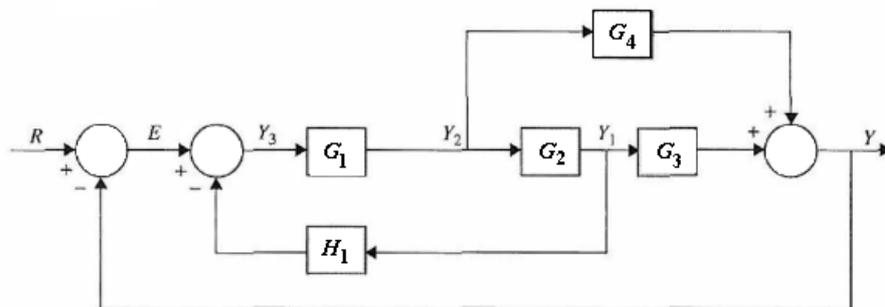
19. Consider the system shown below.
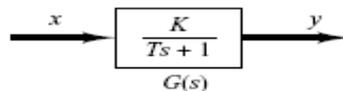
For the sinusoidal input $x(t) = X \sin\omega t$, find the steady-state output $y_{ss}(t)$.

20. What are the advantages of Lag-Lead compensation?

PART C (5 x 14 = 70 Marks)

21. a) (i) Find the input-output transfer function of the system shown below. (7)

(ii) Write the dynamic equation in respect of the mechanical system given below (7) Then using force-voltage analogy obtain the equivalent electrical network.

Legend
K_1, K_2 spring constants
B_1 viscous friction damping coefficient
M_1, M_2 inertial constants of masses
x_1, x_2 displacements
F (t) .. Force.
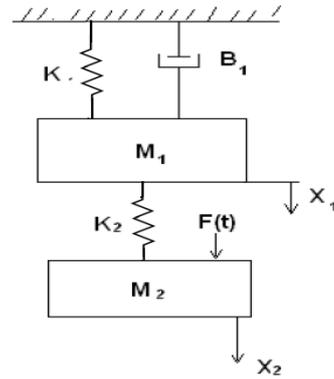
(OR)

b)   Describe a two phase a.c. servomotor and derive its transfer function.

22. a) (i)   For the system shown in the block diagram determine the values of gain K_1 and   (7)
            velocity feedback constant K_2 so that the maximum overshoot with a unit step
            input is 0.25 and the time to reach the first peak is 0.8 sec. Also obtain the rise
   time and settling time for 5% tolerance band.
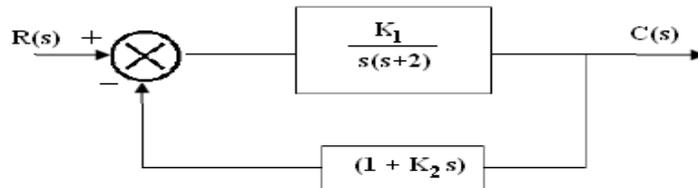
    (ii)   For the standard second order system shown below, with r (t) = u (t) explain how   (7)
            the time domain specifications corresponding to resonant peak and bandwidth
            can be inferred.
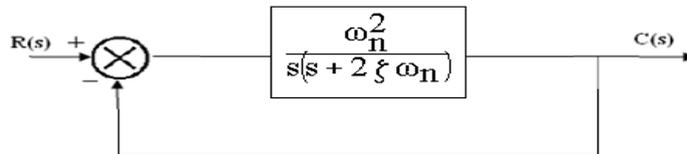
(OR)

b) (i)   Consider the system shown below in Fig.(a). The steady-state error to a unit-   (10)
            ramp input is $e_{ss}=2\zeta/\omega_n$. Show that the steady-state error for following a ramp
            input may be eliminated if the input is introduced to the system through a
            proportional-plus-derivative filter, as shown in Fig.(b), and the value of k is
            properly set.

            Fig.(a)   Fig.(b)
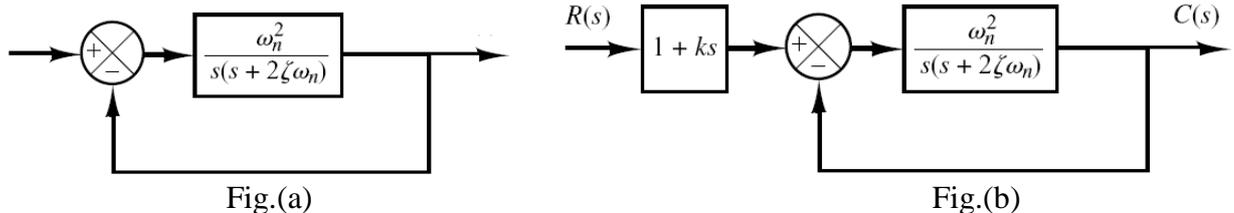
    (ii)   Explain why the proportional control of a plant that does not possess an   (4)
            integrating property suffers offset in response to step inputs.

23. a)   Consider the plant

$$P(s) = \frac{s-2}{(s+3)(s^2+2s+17)}$$

in a feedback loop with a gain K>0. Sketch the Bode plot.

(OR)

b) (i) Consider the plant   (8)

$$P(s) = \frac{s-2}{(s+3)(s^2+2s+17)}$$

in a feedback loop with a gain K>0. Sketch the root locus.

(ii) By applying Routh's criterion to the system above, find the range of $K > 0$ such (6)
that the system is asymptotically stable.

24. a) (i) The transfer functions for a single-loop non-unity-feedback control system are (9)
given as

$$G(s) = \frac{1}{s^2+s+2}, \qquad H(s) = \frac{1}{s+1}$$

Find the steady-state errors due to a unit-step input, a unit-ramp input and a
parabolic input.

(ii) Obtain the unit-impulse response of a unity feedback control system whose open (5)
loop transfer function is

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

**(OR)**

b)   The loop transfer function of a single feedback-loop control system is given as

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}$$

Apply the Nyquist criterion and determine the range of values of K for the
system to be stable.

25. a)   Consider the system shown below. Design a compensator such that the closed-
loop system will satisfy the requirements that the static velocity error
constant=20 sec^{-1}, phase margin=50°, and gain margin ≥ 10 dB.
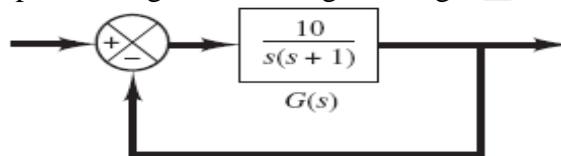
(OR)

b) (i) Consider the characteristic equation   (10)

$$s^4 + 2s^3 + (4+K)s^2 + 9s + 25 = 0$$

Using the Routh's stability criterion, determine the range of K for stability.
Find the number of roots of characteristic equation which lie in the right half of
s-plane for K =100.

(ii) Show that the lead network and lag network inserted in cascade in an open loop (4)
act as proportional-plus-derivative control (in the region of small ω) and
proportional-plus-integral control (in the region of large ω), respectively.

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