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

Question Paper Code: 50343

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2017

Fourth Semester

Electrical and Electronics Engineering

15UEE403 - CONTROL SYSTEMS

(Regulation 2015)

Duration: Three hours | Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. For open control system which of the following statements is incorrect

   (a) Less expensive
   (b) Recalibration is not required for maintaining the required quality of the output
   (c) Construction is simple and maintenance easy
   (d) Errors are caused by disturbances

2. Mass, in force-voltage analogy, is analogous to

   (a) charge (b) current (c) inductance (d) resistance

3. Velocity error constant of a system is measured when the input to the system is unit ________ function.

   (a) parabolic (b) ramp (c) impulse (d) step

4. Which of the following is exhibited by Root locus diagrams?

   (a) The poles of the transfer function for a set of parameter values
   (b) The bandwidth of the system
   (c) The response of a system to a step input
   (d) The frequency response of a system

5. At which frequency does the magnitude of the system becomes zero dB?

   (a) Resonant frequency (b) Cut-off frequency
   (c) Gain crossover frequency (d) Phase crossover frequency

6. Phase margin of a system is used to specify which of the following?

   (a) Frequency response (b) Absolute stability
   (c) Relative stability (d) Time response

7. The number of sign changes in the element of the first column of the Routh array denotes

   (a) the number of zeros of the closed loop system in the RHP
   (b) the number of poles of the closed loop in the RHP
   (c) the number of zeros of the closed loop system in the LHP
   (d) the number of poles of the closed loop in the LHP

8. 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

9. The number of state variable of a system is equal to

   (a) the number of integrators present in the system
   (b) the number of differentiators present in the system
   (c) the sum of the number of integrators and differentiators present in the system
   (d) none of the these

10. An n x n matrix is said to be nonsingular if the rank of the matrix is r is

   (a) $r \neq n$ (b) r = n (c) r = n/2 (d) r = 2n

PART - B (5 x 2 = 10 Marks)

11. Distinguish between open and closed loop control systems.

12. Define rise time and peak time.

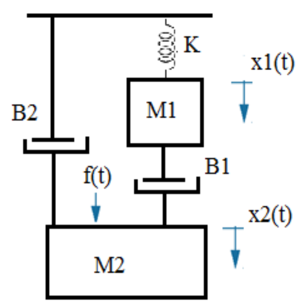
13. Define gain margin and phase margin.

14. State Routh's stability criterion.

15. How can you obtain the transfer function of a system from its state model?

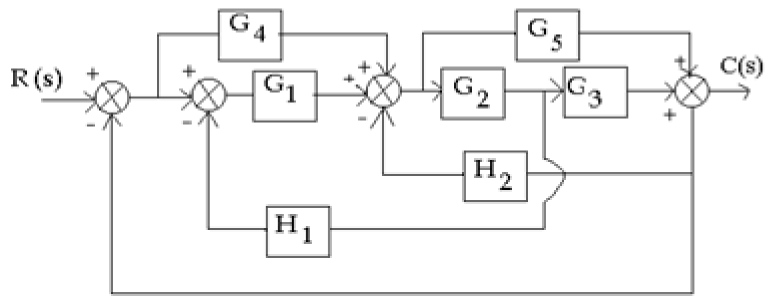
PART - C (5 x 16 = 80 Marks)

16. (a) Obtain the transfer function $\frac{X_1(s)}{F(s)}$ and $\frac{X_2(s)}{F(s)}$ of the mechanical system shown in below figure. (16)



Or

(b) Draw the signal flow graph for the given block diagram, and obtain the transfer function using Mason's gain formula. (16)



17. (a) (i) Determine the closed loop transfer function of the system If is the x input and y is the output, of the system described by a differential equation $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 8y = 8x$, determine time response of the system and also obtain the undamped natural frequency, damping ratio, damped frequency, time for peak overshoot, rise time and settling time. (10)

(ii) For a system with $GH(s) = \frac{5}{s+5}$, calculate the generalized error co-efficient and the steady state error. Assume $r(t) = 6 + 5t$. (6)

Or

(b) The open loop transfer function of a control system is given by $G(s) = \frac{k(s+2)}{s^2(s+5)}$. (16)

18. (a) Sketch the Bode plot of the open loop transfer function is $G(s) = \frac{10k}{s(s^2+4s+25)}$

Determine the value of k so that gain cross over frequency is 3 rad / sec. For this value of k, what is gain margin and phase margin. (16)

Or

(b) Sketch polar plot of the open loop transfer function of system is $G(s) = \frac{1}{s(1+s)(1+4s)}$. (16)

19. (a) (i) Given the forward path transfer function of utility feedback control system as $G(s) = \frac{k(s+10)(s+20)}{s^2(s+2)}$. Apply Routh's criterion to determine the stability of a closed loop system as a function of k. (8)

(ii) Sketch the Nyquist plot for a feedback control system has $G(s)=\frac{40}{(s+4)(s^2+2s+2)}$. Find Gain Margin and stability from Nyquist plot. (8)

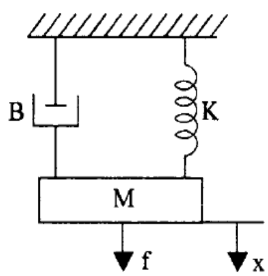
Or

(b) A unity feedback system has an open loop transfer function, $G(s)=\frac{k}{s(0.5s+1)}$ Design a suitable lag compensator so that Phase margin is 30^0 and the steady state error for ramp input is less than or equal to 0.4. (16)

20. (a) (i) Find the state matrix A and output matrix C in the equation

$$\frac{d^3y}{dt^3}+7\frac{d^2y}{dt^2}+9\frac{dy}{dt}+10y=\frac{d^3u}{dt^3}+6\frac{d^2u}{dt^2}+8\frac{du}{dt}+6u.$$ (8)

(ii) Obtain the state space representation for the mechanical system shown in below figure. Taking the displacement and velocity of the mass as state variables. (8)



Or

(b) Determine whether the system described by the following state equation is completely state controllable and observable. (16)

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u\ ; \qquad y=\begin{bmatrix}1 & 1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$