



SF-8187

B. E. - II (Sem. IV) (Electrical/EC/IC) Examination
May / June - 2011
Control Theory
(New Syllabus)

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दृष्टावेक निशानीवाणी विगतो उत्तरवही पर अवश्य कभवी.
Fillup strictly the details of signs on your answer book.

Name of the Examination :
B. E. - 2 (SEM. 4) (ELECTRICAL / EC / IC)

Name of the Subject :
CONTROL THEORY (NEW)

Subject Code No. : 8 1 8 7 Section No. (1, 2,.....) : NIL

Seat No. :

Student's Signature

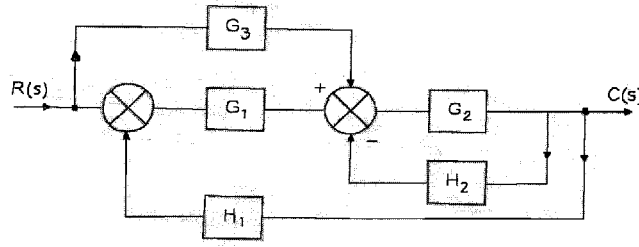
- (2) Attempt all questions.
(3) Figures to the right indicate full marks.
(4) Assume necessary data wherever required.
(5) Scientific calculator up to Casio-100D, 100MS series is permitted.

- 1 (a) Do as directed : 10
(i) What is meant by control system ? 1
(ii) What is Transfer function ? What are limitation of transfer function? 2
(iii) For the system shown below, show that 3

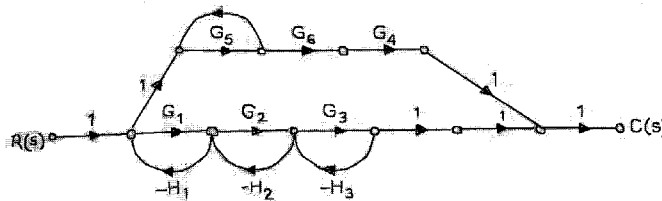
$$C(s)/R(s) = \frac{G(s)}{1 + G(s)H(s)}$$

- (iv) Match the following : 2
- | Mechanical System | Electrical Voltage system |
|-------------------|---------------------------|
| (i) Force (F) | (a) Resistance |
| (ii) Damper (B) | (b) Inductor |
| (iii) Spring (K) | (c) Capacitor |
| (iv) Mass M) | (d) Voltage |
- (v) Define settling time and peak time.

- (b) Find out transfer function $C(s)/R(s)$ for the fig. by using block diagram reduction method. 6



- (c) Write down difference between Open loop system and closed loop system with example. 4
- 2 (a) Derive the output response of standard second order system subjected to a unit step input. 8
- (b) Find out transfer function for the fig. by using SFG. 7



OR

- 2 (a) Define steady state error of feedback control system. Define various static error constants and derive the expression each one. 7
- (b) Fig. (3) shows a mechanical vibratory system. When 2N force is applied to the system, the mass oscillates as shown in fig (b). Determine the values of M, B and K of the system from this response. 8

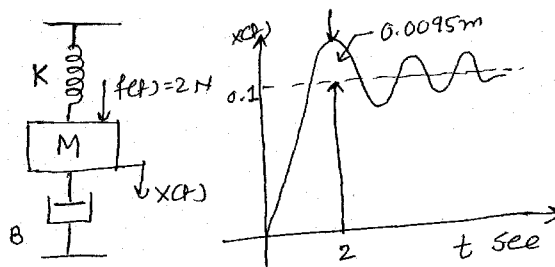
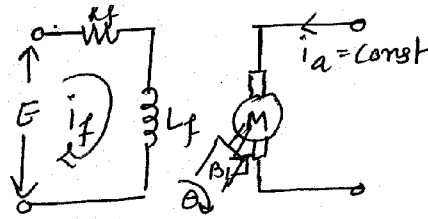


Fig. 3

- 3 Attempt any three : 15
- (i) A field controlled DC motor with constant armature current as shown fig. 4 drives a load. The moment of inertia of the motor and load together is $J \text{ kg-m}^2$ and the equivalent viscous friction for them $B \text{ N-m/rad/sec}$. The motor has field resistance R_f ohms and inductance of L_f henrys. Draw the block diagram indicating the transfer function of each block and obtain the overall transfer function $\theta(s)/E(s)$.



- (ii) Obtain the derivation of transfer function from the state equation of a system.
- (iii) A system has $G(s) = \frac{(s+1)}{s^2(s+4)}$ and $H(s) = \frac{2}{s+2}$. Determine the static error constants and steady state error to unit step, ramp and parabolic input function.
- (iv) For RLC series circuit derive state Model, where supply voltage $e(t)$ volt, current through circuit is $i(t)$ ampere.
- (v) For second order characteristics equation show how the location of the closed loop poles will change with the variation in damping.

- 4 (a) Fill in the blanks : 5
- (i) The frequency at which Nyquist diagram crosses the negative real axis is known as _____.
 - (ii) A Rough Hurwitz criterion is a _____ (Time/Frequency) domain approach.
 - (iii) Root locus terminates at zero. The value of K is _____ (zero/infinity) at every zero.
 - (iv) The slope of the magnitude curve of the Bode Plot of $G(j\omega)$ at the gain crossover usually given an indication of _____ (relative/absolute) stability.
 - (v) In a linear system if output approaches infinity, the system is _____ (stable/unstable).
- (b) State whether following statements are true/false : 5
- (i) Relative stability can be obtained from R H Criteria.
 - (ii) If any odd or even power of 's' is present in system characteristic equation polynomial, then system has sustained oscillation.
 - (iii) M and N circles are applicable to non unity feedback system.
 - (iv) Nichol's chart is time domain tool.
 - (v) If there are three zeros and two poles of $G(s) H(s)$, then there will be three root loci.
- (c) Discuss the stability of the system whose characteristic equation 4
- $$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$$
- (d) Determine the range of K for the system to be stable. 4
- $$S^4 + 5S^3 + 5S^2 + 4S + K = 0$$
- (e) State the limitations of Hurwitz's criterion. 2

- 5 (a) A unity feedback system has a frequency transfer function $G(s) = \frac{1}{S(1+0.1S)(1+S)}$ 9

Plot the necessary data of this system of Nichol's chart and hence, obtain the following :

- (i) Phase margin, gain margin
- (ii) Gain and Phase cross over frequencies
- (iii) Bandwidth

- (b) Discuss in brief procedure of obtaining Nichol's Chart from N-circles and M-circles. 6

OR

- 5 (a) The open loop transfer function of unity feedback control system is given by $G(s) = \frac{K(1+2S)}{S(S+1)(0.5S+1)(1+0.2S)}$ 10

Draw Bode plot in magnitude and phase and hence determine

- (i) The gain margin, phase margin and the corresponding cross over frequencies with $K=10$.
- (ii) The value of K which gives phase margin of 20° .

- (b) The specifications given on a certain second order feedback control system are $\omega_n = 10$ r/s and the overshoot to step input is 40%. 5

(i) What are the corresponding values of the damping ratio and the peak response ?

(ii) Determine also the corresponding value of resonant frequency and the time at which the peak overshoot occurs.

- 6 (a) Draw Nyquist contour and Nyquist plot for the system with 7

$G(s)H(s) = \frac{k}{(s+1)(s+2)(s+3)}$ and hence find the range of values of K for this system to be stable.

- (b) Discuss the Nyquist criterion for stability of a control system with negative feedback and state the theorem of complex variable on which it is based. 8

OR

- 6 (a) (i) Prove mathematically that every Root Locus branch originates at an open Loop pole and terminates either at open loop zero or at infinity. 4

(ii) Explain how find the value of K and ω on Root Locus to touch at the imaginary axis. 3

- (b) Draw the root locus for the open loop transfer function. 8

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