DipIETE – ET (OLD SCHEME)

Code: DE15 **Subject: CONTROL ENGINEERING**
Time: 3 Hours **Max. Marks: 100**

JUNE 2010

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions, answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. The system with the characteristic equation $(s+1)(s+2)(s-3)=0$ is _____.

(A) stable **(B)** marginally stable
(C) not necessarily stable **(D)** unstable

b. Signal flow graph is used to obtain _____.

(A) stability of the system
(B) transfer function of the system
(C) dynamic response of the system
(D) poles of the system

c. The second order system is defined by $\frac{25}{s^2+5s+25}$ is given a step input. The time taken for the response to settle within ± 2% of input is _____.

(A) 1.2 ses **(B)** 1.6 sec
(C) 2 sec **(D)** 0.4 sec

d. For the transfer function $G(s)=\frac{K}{(s+1)(s+2)(s+3)}$, the breakaway point will lie between _____.

(A) 0 and –1 **(B)** –1 and –2
(C) –2 and –3 **(D)** beyond –3

e. If the open loop transfer function G (jw) of a unity feedback system has a phase angle of -150^o at the gain cross-over frequency, the phase margin of the system is equal to _____.

(A) -150^o **(B)** 210^o
(C) 30^o **(D)** -30^o

f. The steady state error of a stable type '0' unity feedback system for a unit step function is given as _____.

(A) 0 **(B)** $\frac{1}{1+K_p}$

(C) ∞ **(D)** $\frac{1}{K_p}$

g. From the Nichols chart, one can determine the following quantities pertaining to closed loop system as:

(A) Magnitude and phase **(B)** Bandwidth
(C) Magnitude only **(D)** Both **(A)** & **(B)**

h. The transfer function of a simple RC network functioning as compensator is $G_c(s) = \frac{s+z_1}{s+p_1}$. The condition for RC network to act as phase lead controller is _____.

(A) $p_1 < z_1$ **(B)** $p_1 = z_1$
(C) $p_1 = 0$ **(D)** $p_1 > z_1$

i. Gain cross-over frequency is defined as the frequency at which _____.

(A) $|G(j\omega)H(j\omega)| = 1$ **(B)** $|G(j\omega)H(j\omega)| = 0$
(C) $|G(j\omega)H(j\omega)| = \infty$ **(D)** $|G(j\omega)H(j\omega)| = 1/2$

j. If stability error for step input and speed of response be the criteria for design, what type of controller would you recommend?

(A) P Controller. **(B)** PD Controller.
(C) PI Controller. **(D)** PID controller.

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q. 2 a. Define state space model and transfer function model. Give advantages and limitations of state space model over transfer function model. **(8)**

b. A unit step signal is applied on the second order system given by $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$. Find the dynamic response for $0 < \zeta < 1$ **(8)**

Q. 3 a. Reduce the block diagram shown in the Fig.1 below and obtain the transfer function. **(8)**

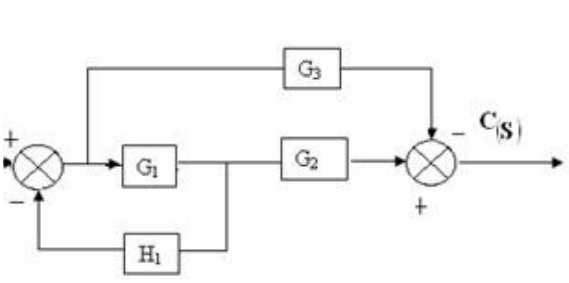

Fig.1

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b. Explain with neat sketches the construction and working of synchros. **(8)**

Q. 4 a. Discuss the basic feedback characteristics of feedback control system. **(8)**

b. Define stability, absolute stability, relative stability and conditional stability. **(8)**

Q. 5 a. Find the steady state error for unit step, unit velocity and unit acceleration inputs for the system with $G(s) = \frac{100}{s^2(0.1s+1)(0.01s+1)}$. **(8)**

b. Sketch the root locus of a unity feedback system with $G(s) = \frac{K(s+3)}{s(s+2)}$. **(8)**

Q. 6 a. Draw the bode plot for the following transfer function and determine the stability margins: **(8)**

$$GH(s) = \frac{100}{s(0.01s+1)}$$

b. What is M-circle? Explain in detail. **(8)**

Q.7 a. Using Nyquist Criterion, comment on the stability of the system whose open loop transfer function is $GH(s) = \frac{1}{(0.5s+1)(0.2s+1)}$. **(8)**

b. With the help of block diagrams explain briefly:
(i) Derivative error and
(ii) Integral error compensation. **(8)**

Q. 8 a. Write short note on:

(i) Use of digital computer as compensator.
(ii) Op-amp. **(8)**

b. State the necessary condition for the Routh's criterion for stability. Determine the stability of the system whose characteristic equation is given by $s^4 + 6s^3 + 23s^2 + 40s + 50 = 0$. **(8)**

Q. 9 a. What is Mason Gain Rule? Obtain $\frac{C}{R}$ for the signal flow graph shown in Fig.2. **(8)**

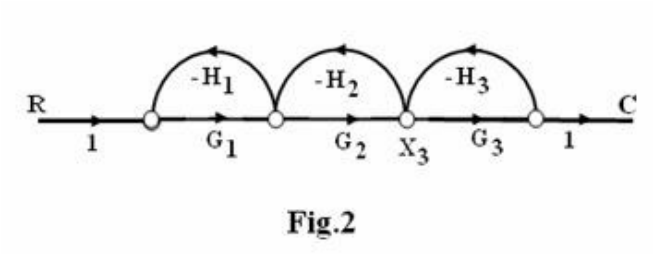

Fig.2

b. Discuss the tuning of PID controllers. **(8)**