Code: DE-15 **Subject: CONTROL ENGINEERING**

JUNE 2007

Time: 3 Hours **Max. Marks: 100**

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 best alternative in the following: (2x10)

a. The characteristic equation of a feedback control system is given by $s^2 + 2s + 8 = 0$. The damping ratio of this system is

(A) 0.353 **(B)** 0.350
(C) 0.30 **(D)** 0.333

b. In feedback control system, the transient response

(A) decays slowly. **(B)** decays rapidly.
(C) rises slowly. **(D)** rises quickly.

c. A system with gain margin close to unity or a phase margin close to zero is

(A) highly stable. **(B)** oscillatory.
(C) non-linear. **(D)** non-oscillatory.

d. The characteristic equation of a feedback control system is given by $s^4 + s^2 + s + 5 = 0$. The system is

(A) stable. **(B)** unstable.
(C) marginally stable. **(D)** conditionally stable.

e. The input to a controller is

(A) sensed signal. **(B)** error signal.
(C) desired variable value. **(D)** servo-signal.

f. In the $G(j\omega)H(j\omega)$ locus shown in Fig.1, the closed loop system will remain stable even if its gain is increased slightly less by a factor of

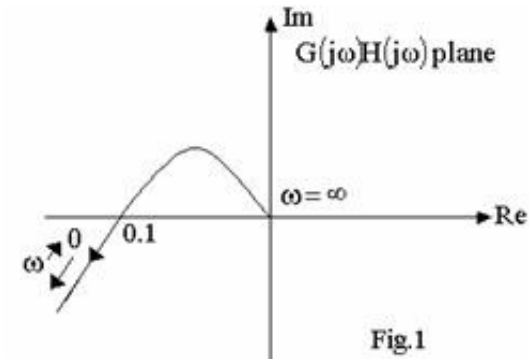

Fig.1

(A) 0.1. **(B)** 0.01.
(C) 10. **(D)** 100.

g. Which of the following devices can measure pressure directly?

(A) LVDT **(B)** Strain gauge
(C) Rotameter **(D)** Bourden tube

h. The impulse response of a linear time invariant system is given by $h(t) = Ke^{-T.t}$. The system can be characterized as

(A) first order. **(B)** second order.
(C) third order. **(D)** fourth order.

i. The system transfer function of the form $G(s) = \frac{K}{(1+sT_1)(1+sT_2)}$ can be represented in the Bode plot at frequencies $\omega >> T_1$ and $\omega >> T_2$ by a slope of

(A) $8dB/octave$ **(B)** $12dB/decade$
(C) $-24dB/decade$ **(D)** $-40dB/decade$

j. For a physically realizable system, its unit impulse response h(t) satisfies

(A) $h(t) < 0$ for $t < 0$ **(B)** $h(t) \leq 0$ for $t < 0$
(C) $h(t) = 0$ for $t < 0$ **(D)** $h(t) = \infty$ for $t < 0$

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

Q.2 a. State and explain Mason's gain formula to find the relation between output and input of a feedback control system. **(8)**

b. Find the gain $\frac{Y_5}{Y_1}$ for the signal flow graph shown in Fig.2. **(8)**

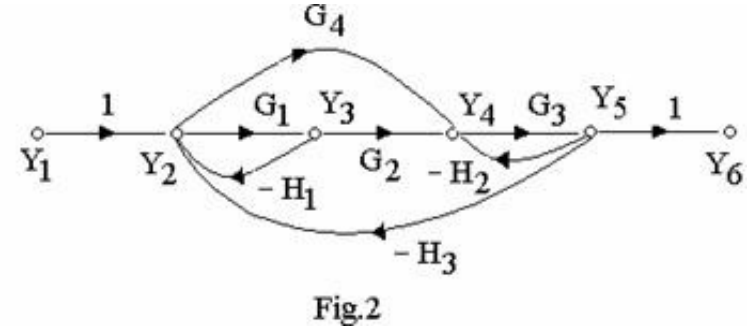

Fig.2

Q.3 a. The characteristic equation of a feedback control system is given as $s^4 + 2Ks^3 + 2s^2 + (1+K)s + 2 = 0$. Determine the value of K so that the system is marginally stable and frequency of sustained oscillation if applicable. **(8)**

b. State and explain Routh-Hurwitz criterion to find the stability of a closed-loop control system. **(8)**

Q.4 The open-loop transfer function of a unity feedback control system is given as $G(s) = \frac{K}{s(s+a)(s+30)}$. Where 'a' and 'K' are real constants.

Find the values of 'a' and 'K' so that the relative damping ratio of the complex roots of the characteristic equation is 0.5 and the rise time of the unit-step response is approximately 1 second. **(8+8)**

Q.5 a. Explain the terms

(i) steady-state error and

(ii) types of control system. **(4)**

b. Determine the step, ramp and parabolic error constants of the unity-feedback control system whose open-loop transfer function is given as $G(s)H(s) = \frac{1000}{s(s+10)(s+100)}$. **(12)**

Q.6 The characteristic equation of a feedback control system is given as $s^3 + 4s^2 + 8s + K = 0$. Construct the root loci for $0 < K < \alpha$. **(16)**

Q.7 a. Find the unit-step response of a unity-feedback control system whose open-loop transfer function is $G(s) = \frac{4}{s(s+5)}$. **(12)**

b. Obtain the unit impulse response of a unity feedback control system whose open-loop transfer function is $G(s) = \frac{2s+1}{s^2}$. **(4)**

Q.8 a. Explain with the help of polar plot of $G(j\omega)H(j\omega)$, the terms
(i) gain margin (ii) phase margin. **(6)**

b. For the Control system shown in Fig.3, find the gain K such that phase margin is 50° . **(10)**

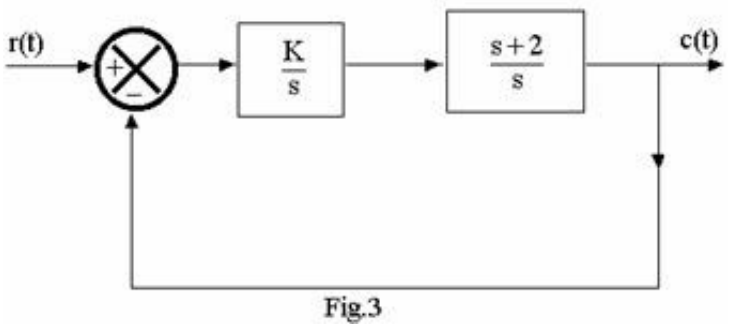

Fig.3

Q.9 Write short notes on any **TWO** of the following:-

(i) P-I-D controller.
(ii) Two phase motor.
(iii) Synchros. **(16)**