ROLL NO. ___________________

Code: DE65 **Subject: CONTROL ENGINEERING**

DipIETE – ET

Time: 3 Hours **DECEMBER 2013** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **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 damping ratio of a system having the characteristic equation $s^2+2s+8=0$ is

(A) 0.353 **(B)** 0.330
(C) 0.300 **(D)** 0.250

b. The laplace transform of $e^{-2t}\sin 2\omega t$ is

(A) $\frac{2\omega}{(s+2)^2+2\omega^2}$ **(B)** $\frac{2s}{(s-2)^2+4\omega^2}$
(C) $\frac{2\omega}{(s+2)^2+4\omega^2}$ **(D)** $\frac{2\omega}{(s+2)^2-2\omega^2}$

c. Stability of open loop is

(A) greater than closed loop **(B)** lesser than closed loop
(C) equals to closed loop **(D)** none of these

d. The impulse response of the standard second order system can be obtained from its unit step response by

(A) integrating **(B)** a derivating
(C) inverse laplace of function **(D)** transfer function

e. The transfer function of the block diagram Fig.1 is

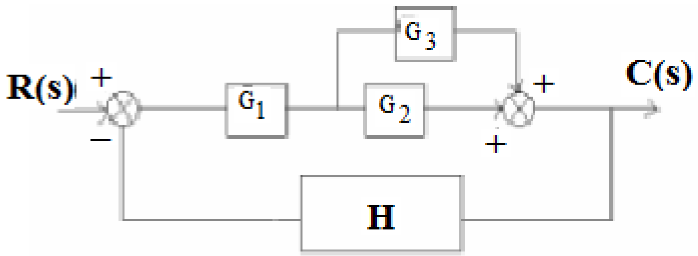

Fig.1

(A) $\frac{G_2(G_1+G_3)}{1+G_1G_2H+G_1G_3H}$ **(B)** $\frac{G_1(G_2+G_3)}{1+G_1G_2H+G_1G_3H}$

(C) $\frac{G_1(G_2-G_3)}{1+G_1G_2H+G_1G_3H}$ **(D)** $\frac{G_1(G_2+G_3)}{1+G_1H+G_3H}$

f. For a standard second-order system described by $s^2+2\zeta\omega_n s+\omega_n^2$, the term $1/\zeta\omega_n$ indicates

(A) time-constant **(B)** damping factor
(C) natural frequency **(D)** none of these

g. Lead-lag compensation is needed for

(A) transient response improvement
(B) steady state response improvement
(C) both transient and steady state response improvement
(D) none of these

h. The input to a controller is

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

i. If the Nyquist plot of the loop transfer function G(s) H(s) of a closed-loop system encloses the (-1, j0) point in the G(s) H(s) plane, the gain margin of the system is

(A) zero **(B)** greater than zero
(C) less than zero **(D)** infinity

j. The principles of homogeneity and superposition are applied to

(A) linear time variant system **(B)** non-linear time variant system
(C) linear time invariant systems **(D)** non-linear time invariant systems

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

Q.2 a. Define control system. When is a control system said to be robust? **(8)**

b. Define the following terms in respect of feedback control system: **(8)**
(i) Feed forward element
(ii) Control signal
(iii) Feedback element
(iv) Actuating signal

Q.3 a. Define the transfer function of a linear time-invariant system in terms of its differential equation model. What is the characteristic equation of the system? **(8)**

b. Obtain the Unit-step response of a unity-feedback whose open-loop transfer function is $G(s) = \frac{5(s+20)}{s(s+4.59)(s^2+3.14s+16.35)}$ **(8)**

Q.4 a. Explain the procedure to be followed when in the Routh's array all the elements of a row corresponding to S^4 are zeros. **(4)**

b. Write short note on compensation. **(6)**

c. Obtain the transfer function for RLC circuit shown in Fig.2 below. **(6)**

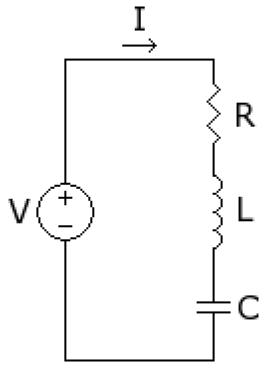

Fig.2

Q.5 a. For the system whose signal flow graph is shown by Fig.3, find $\frac{Y(s)}{R(s)}$ **(6)**

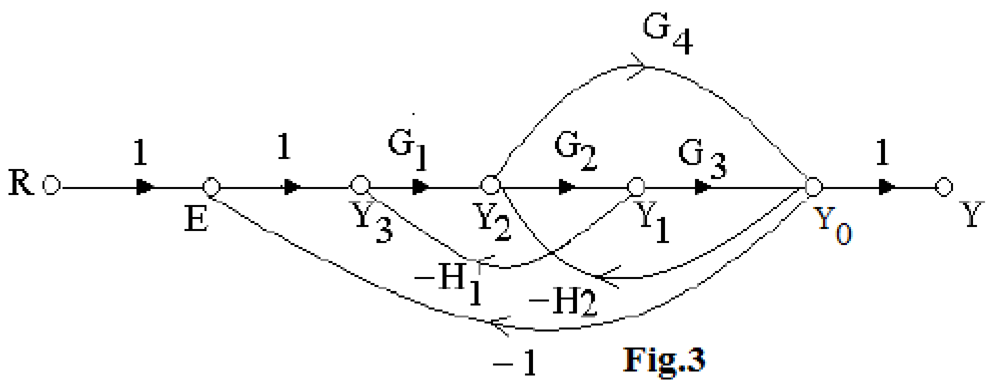

Fig.3

b. Determine the transfer function $\frac{C(s)}{R(s)}$ for the block diagram shown in Fig.4 by first drawing its signal flow graph and then using the Mason's gain formula. **(10)**

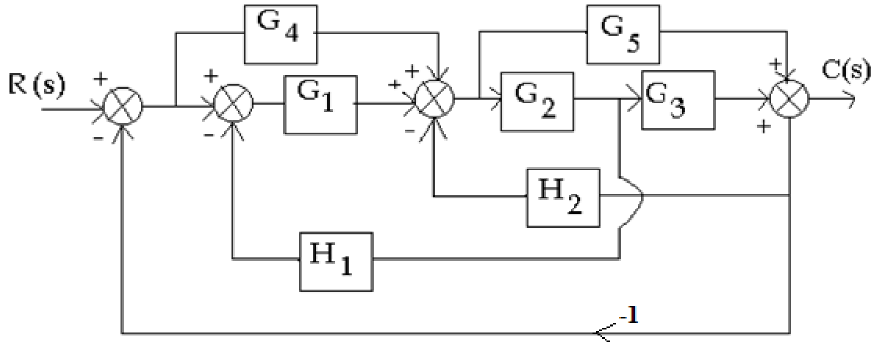

Fig.4

Q.6 a. The transfer functions for a single-loop non-unity-feedback control system are given as $G(s) = \frac{1}{s^2 + s + 2}$ and $H(s) = \frac{1}{s+1}$. Find the steady-state errors due to a unit-step input, a unit-ramp input and a parabolic input. **(8)**

b. Define sensitivity. Discuss the sensitivity of transfer function with different parameters. **(8)**

Q.7 Construct root locus and comment on the stability of a unity-feedback control system having the open-loop transfer function $G(s) = \frac{10}{s(s-1)(2s+3)}$ **(16)**

Q.8 a. Explain the properties of polar plots. **(6)**

b. Use the Nyquist criterion to determine the range of values of K>0 for the stability of the system in Fig.5. **(10)**

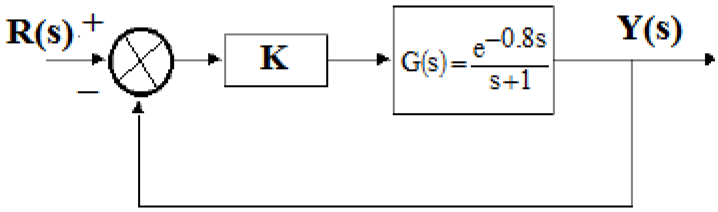

Fig.5

Q.9 A unity-feedback system has open-loop transfer function $G(s) = \frac{4}{s(s+1)(s+2)}$

(i) Using Bode plots of G(jw), determine the phase margin of the system.
(ii) How should the gain be adjusted so that phase margin is 50°? **(16)**