ROLL NO. _____

Code: DE65 **Subject: CONTROL ENGINEERING**

DipIETE – ET

Time: 3 Hours **JUNE 2014** **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. Following facts apply to any closed-loop control system:

(A) Complex in construction
(B) Comparatively difficult to maintain than an open-loop control system
(C) Over all system may be more expensive
(D) All of these

b. Stability problem is faced in

(A) All open-loop control systems
(B) Most closed-loop control systems
(C) Neither in open-loop nor in closed-loop control systems
(D) Both in open loop and closed-loop control systems

c. The concept of transfer function applies to

(A) linear time varying systems
(B) linear and non- linear systems
(C) linear time invariant systems
(D) only for MIMO systems

d. Which one of the following response-excitation relationship represents a linear control system?

(A) $y = k_1x^2$ **(B)** $y = 7x + 15$

(C) $y = 5x$ **(D)** $y = k_4$

e. Laplace transform of a unity step function is

(A) $\frac{1}{s^2}$ **(B)** s

(C) 1 **(D)** $\frac{1}{s}$

f. The inverse Laplace transform of $\frac{5}{s+2}$ is

(A) $5\,e^{-2t}$ **(B)** $2e^{-2t}$

(C) $\frac{5}{2}e^{-t}$ **(D)** $\frac{5}{2}e^{-2t}$

g. Routh- Hurwitz criterion gives

(A) absolute stability **(B)** relative stability
(C) comparative stability **(D)** specific stability

h. For the signal flow graph shown in Fig.1 the overall gain is

(A) $\frac{g_{32}}{1-g_{22}}$

(B) $\frac{g_{12}g_{32}}{1-g_{22}}$

(C) $\frac{g_{21}g_{32}}{1+g_{22}}$

(D) $\frac{g_{21}}{1-g_{23}}$

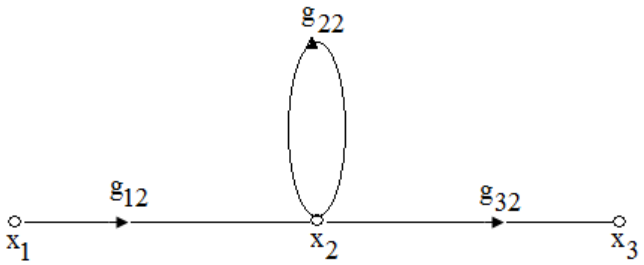

Fig.1

i. What can you say about the stability of the system whose Nyquist plot is shown in Fig.2

(A) Stable
(B) Unstable
(C) Marginally stable
(D) Conditionally stable

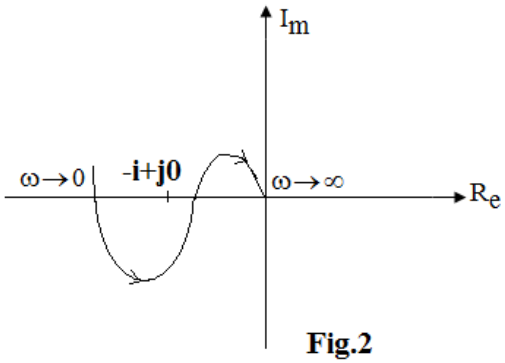

Fig.2

j. The root- loci of a closed loop control system is shown in Fig.3, then the system is

(A) stable for $k \le 9$
(B) unstable for all values of k
(C) stable for all values of k
(D) unstable for $k \ge 9$

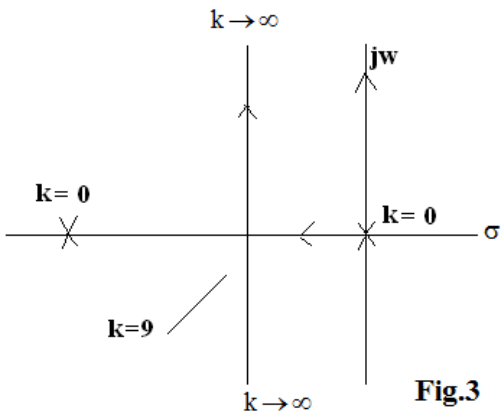

Fig.3

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

Q.2 a. In reference to control system engineering define the following terms:
(i) plant (ii) reference input
(iii) actuating signal (iv) forward path **(2×4=8)**

b. Draw the block diagram for whose dynamics is represented by the following equation $y = ax_1 + bx_2 + cx_3$ **(8)**

Q.3 a. Explain the meaning of steady state responses and transient response. **(2×4=8)**

b. Determine the partial fraction expansion of the rational function given below

$$F(s) = \frac{1}{(s+1)^2(s+2)}$$ **(8)**

Q.4 a. Explain the concepts of stability and relative stability of control systems. **(8)**

b. Reduce the following block diagram to unity feedback form and find the system characteristic equation. **(8)**

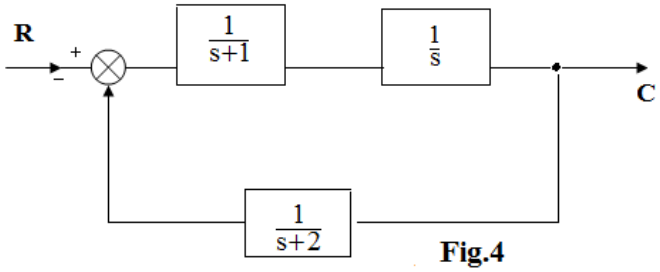

Fig.4

Q.5 a. Explain the general input-output Gain formula for applied to signal flow graphs for control systems. **(8)**

b. Determine the ratio $\frac{C(s)}{V(s)}$ for a system whose signal flow graph is shown in Fig.5. **(8)**

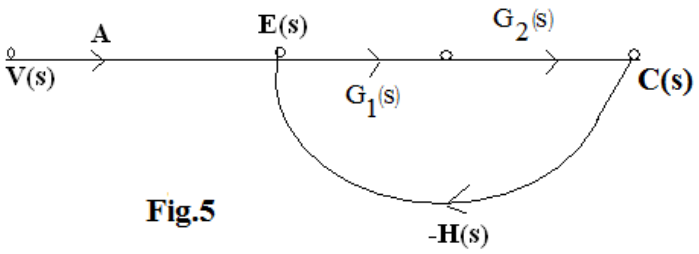

Fig.5

Q.6 a. Define the various types of error constants in reference to control system engineering. **(8)**

b. Determine the resonance peak M_p and the resonant frequency ω_p for the system whose transfer function is $\frac{C(s)}{R(s)} = \frac{5}{s^2 + 2s + 5}$ **(8)**

Q.7 a. In reference to linear control systems analysis explain what do you understand by polar plot. Also, explain its merits and limitation as compared to Bode plot method for control system analysis. **(8)**

b. What do you understand by the term 'Relative Stability' of a system? Explain the terms gain margin and phase margin with the help of Nyquist plot. **(8)**

Q.8 a. The pole zero plot of a second – order control system is given in Fig.6. Draw the root- loci for this system. **(8)**

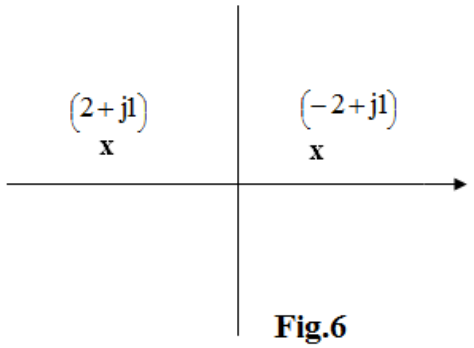

Fig.6

b. In reference to root- locus method, find the angles and centre of, and sketch the asymptotes for

$$GH = \frac{k(s+2)}{(s+10)(s+3+j)(s+3-j)(s+4)},\ k > 0$$ **(8)**

Q.9 a. Explain the following in reference to Bode plots.

(i) Why do we plot frequency on logarithmic scale in Bode plots?

(ii) Why do we plot gain magnitude on logarithmic scale in Bode plots?

(iii) Why don't we plot phase angle on logarithmic scale on Bode plots?

(3+3+2)

b. Give a step-wise procedure for drawing the Bode plots for general linear control system. Illustrate with the help of an example. **(8)**