ROLL NO. _____

Code: DE65 **Subject: CONTROL ENGINEERING**

DipIETE – ET (Current Scheme)

Time: 3 Hours **June 2018** **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 inverse Laplace transform of $\frac{5}{s^2+2}$ is

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

(C) $\frac{5}{2}\cos 2t$ **(D)** $\frac{5}{\sqrt{2}}\sin\sqrt{2}t$

b. A system can be completely described by a transfer function, if it is
(A) nonlinear and continuous **(B)** Linear and time –invariant
(C) linear and time varying **(D)** Nonlinear and time –invariant

c. The Gain and Phase margins of G(s) for closed loop stability are
(A) 6dB and 90^0 **(B)** 3dB and 180^0
(C) 3dB and 90^0 **(D)** 6dB and 180^0

d. The initial slope of the Bode plot for a transfer function having double zero at origin is
(A) -20 dB/decade **(B)** 20 dB/decade
(C) -40 dB/decade **(D)** 40 dB/decade

e. The electrical capacitance is analogous to
(A) Spring **(B)** Mass
(C) Viscous damper **(D)** None of these

f. Laplace transform of a unity step function is
(A) 1/s **(B)** s
(C) $1/s^2$ **(D)** 1

g. The damping ratio of a system having the characteristic equation $s^2+2s+8=0$ is
(A) 0.330 **(B)** 0.230
(C) 0.353 **(D)** 0.253

h. 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) damping factor **(B)** time constant
(C) natural frequency **(D)** None of these

i. Laplace transform of integral of f(t) is

(A) F(s) **(B)** sF(s) – f(0)
(C) sF(s) **(D)** $s^2F(s)$

j. The transfer function of the network as shown in Fig. 1 is

(A) 1/(1 + sRC) **(B)** sRC/(1 + sRC)
(C) RC/(1 + sRC) **(D)** (1 + sRC)/(1 - sRC)

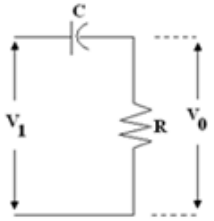

Fig. 1

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

Q.2 a. Compare open loop & closed loop control systems using suitable example. **(6)**

b. Differentiate the following: **(6)**
(i) Continuous & discrete control systems
(ii) Analog & Digital control systems

c. Discuss the computer controlled systems with the help of its block diagram. **(4)**

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

b. Obtain the Solution of the differential equation given below **(8)**
$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = 0$
Given $x(0+) = 0$ and $x'(0+) = 1$

Q.4 a. Obtain the closed loop transfer function C(s)/R(s) of the system whose block diagram is shown in Fig.2

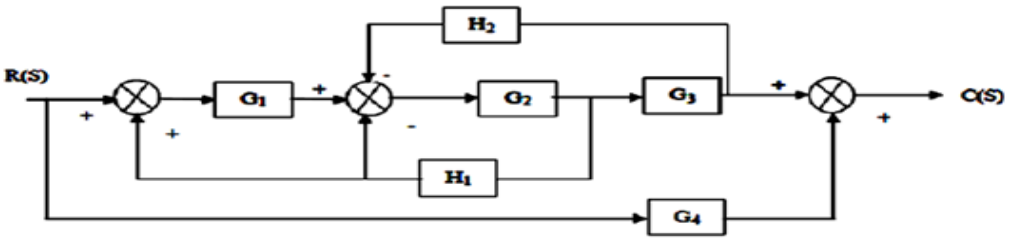

Fig.2

b. Define stability. Use continued fraction stability criterion to determine stability of the characteristic equation: $s^4 + 4s^3 + 8s^2 + 16s + 32 = 0$. **(8)**

Q.5 a. Explain the following rules of signal flow graph: **(2x3)**
(i) Addition rule (ii) Transmission rule (iii) Multiplication rule

b. For the system whose signal flow graph is shown by Fig.3, find $\frac{Y(s)}{R(s)}$ **(10)**

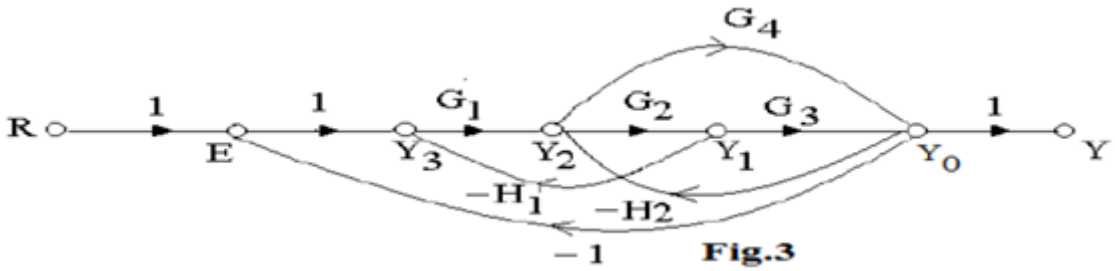

Fig.3

Q.6 a. A unity negative feedback system has open loop transfer function of

$$G(s) = \frac{K}{s+4}$$

Consider a cascade compensator $G_c(s) = \frac{s+\alpha}{s}$

Select the value of K & α to achieve
(i) Peak over shoot of 20%
(ii) Setting time (2% basis) ≅ 1 sec **(10)**

b. Explain gain margin and phase margin. **(6)**

Q.7 a. Sketch the Nyquist Stability plot for the Open loop transfer function given by $GH(s) = \frac{1}{(s+p_1)(s+p_2)}$ $p_1, p_2 > 0$ **(10)**

b. Define the following with respect to a Nyquist plot **(1.5x4)**
(i) Encircled (ii) Enclosed
(iii) Analytic function (iv) Single-valued function

Q.8 a. Sketch the root locus of the system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$. Find the range of *K* for which the system is stable. **(10)**

b. Explain the properties of polar plots. **(6)**

Q.9 a. Obtain Bode Plots for the system: **(10)**

$$G(s) = \frac{1000}{(0.1s+1)(0.001s+1)}$$

Also obtain GM and PM. Comment on stability.

b. Give a step-wise procedure for drawing the Bode plots for general linear continuous time control system. Illustrate with the help of an example. **(6)**