Code: DE65   **Subject: CONTROL ENGINEERING**

DipIETE – ET (Current Scheme)

Time: 3 Hours | **DECEMBER 2015** | **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. In position Control Systems, the device used for providing rate–feedback voltage is
   (A) Potentiometer   **(B)** Synchro –transmitter
   (C) Synchro –transformer   **(D)** Tachogenerator

b. A Phase –lag Compensation will
   (A) Improve relative Stability   **(B)** Increase the speed of response
   (C) Increase bandwidth   **(D)** Increase overshoot

c. Mason's Rule is applied to
   (A) Signal flow graph   **(B)** Block diagram reduction technique
   (C) Hydraulic system   **(D)** Nyquist plot

d. The Laplace transform of the function i (t) is

$$I(S) = \frac{10s + 4}{s(s + 1)(s^2 + 4s + 5)}$$, The Final Value is

   (A) $\dfrac{4}{5}$ **(B)** $\dfrac{5}{4}$
   (C) 4   **(D)** 5

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

f. The transfer Function of System is Given as

$$\frac{100}{s^2 + 20s + 100}$$

   The System is
   (A) An Over damped System.   **(B)** An under-damped system.
   (C) A Critically damped System.   **(D)** An Unstable system

g. The Solution the Differential Equation

$$\frac{d^2 y}{dt^2} + 2\frac{dy}{dt} + 2y = 3$$

   (A) Oscillatory   **(B)** Over-damped
   (C) Under-damped   **(D)** Critically damped

h. For Type 2 System, the Steady state error due to ramp input is equal to
   (**A**) Zero   (**B**) Finite constant
   (**C**) Infinite   (**D**) Indeterminate

i. The bode diagram approach is the most commonly used method for the analysis an synthesis of
   (**A**) Nonlinear feedback control systems only
   (**B**) Linear feedback control systems only
   (**C**) Open loop system
   (**D**) All of these

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

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

Q.2 **a.** Define the open loop control system and closed loop control system. Write Comparison between open loop control system and closed loop control system. **(8)**

  b. Define Servomechanisms and regulators. Explain and Draw the Schematics and Block diagram for servomechanism of Water valve positioning with help of Potentiometer. **(8)**

Q.3 a. Derive the Laplace Transform of the following function.
   (i) e^{at}
   (ii) Sinωt **(8)**

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

Q.4 a. Define the Transfer function and Derive it for the given electrical network. **(8)**
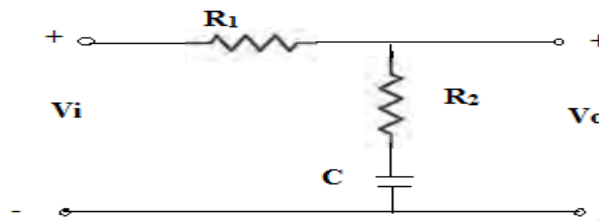

Figure 1

  b. For the block diagram shown in fig. 2, determine the overall transfer function using block diagram reduction technique. **(8)**
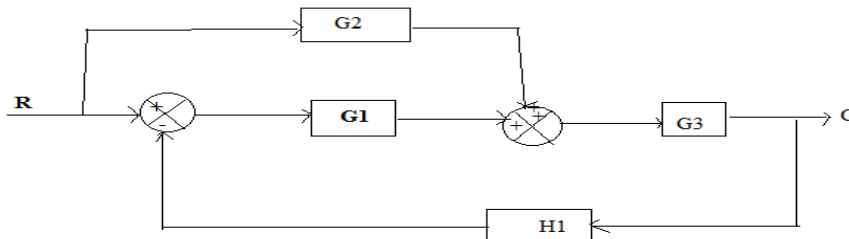

Figure 2

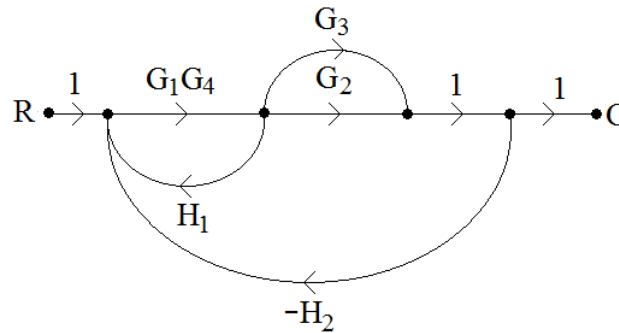**Q.5** a. Find the Transfer function C/R for the system shown in fig.3 using Mason's gain formula. **(8)**

Figure 3

b. Explain transfer function computation of cascaded components using suitable example. **(8)**

Q.6 **a.** Derive Static error constant K_p, K_v, and K_a for unit step, unit ramp and unit parabolic input. **(8)**

b. For a Unity feedback control system the forward path transfer function is given by

$$G(s) = \frac{20}{s(s+2)(s^2+2s+20)}$$

Determine the Steady state error of the system, when the inputs are: **(8)**

(i) 5   (ii) 5t   (iii) $\frac{3t^2}{2}$.

Q.7 a. (i) Explain the Nyquist Stability criterion.
(ii) Write the Properties of POLAR plots. **(2x4)**

b. Sketch the Nyquist Stability plot for the Open loop transfer function given by

$$GH(s) = \frac{1}{(s+p_1)(s+p_2)} \qquad p_1, p_2 > 0$$ **(8)**

Q.8. a. A unity feedback control system has an open loop transfer function

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

Draw the root locus and determine the value of K if the damping ratio ξ is to be 0.707 **(8)**

b. Find break away point between 0 and 1 for $GH = \dfrac{K}{s(s+1)(s+3)(s+4)}$. **(4)**

c. Determine angle of departure for complex poles and angle of arrival for complex zeroes for $GH = \dfrac{K(s+1+j)(s+1-j)}{s(s+2j)(s-2j)}$ here K>0. **(4)**

Q.9 a. Define Gain margin, Phase margin, Gain Cross Over frequency and Phase cross over frequency. **(2x4)**

b. Sketch the Bode Plot for the Open –loop transfer function for the unity feedback system given below and assess stability.

$$G(S) = \frac{50}{(s+1)(s+2)}$$ **(8)**