

**DiplETE – ET (Current Scheme)**

Time: 3 Hours

**DECEMBER 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 value of function  $F(s) = \frac{2}{s^2 + 3}$  at  $t = 0+$  is

- (A) 3 (B) 2  
(C) 3/2 (D) Zero

b. The natural frequency of oscillations of the output for the equation

$$\frac{d^2x}{dt^2} + 1.5 \frac{dx}{dt} + 4x = 1 \text{ is}$$

- (A) 0 rad/sec (B) 1.5 rad/sec  
(C) 2 rad/sec (D) 4 rad/sec

c. The equation governing a control system is given by

$$\frac{d^2c(t)}{dt^2} + 5 \frac{dc(t)}{dt} + 4c(t) = 3r(t)$$

The transfer function of the system is

- (A)  $\frac{3}{(s+1)(s+4)}$  (B)  $\frac{5}{(s+1)(s+4)}$   
(C)  $\frac{1}{s^2 + 3s + 4}$  (D)  $\frac{4}{s^2 + 3s + 5}$

d. Which one of the following transfer function exhibit least steady state error for ramp input

- (A)  $\frac{9}{s^2 + 2s + 9}$  (B)  $\frac{16}{s^2 + 2s + 16}$   
(C)  $\frac{25}{s^2 + 2s + 25}$  (D)  $\frac{36}{s^2 + 2s + 36}$

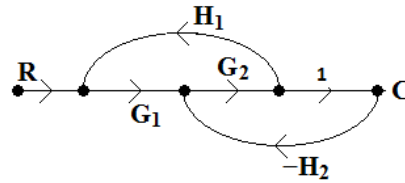
e. The loop gain  $G(s)H(s)$  of a closed loop system is given by  $K/s(s+2)(s+4)$ . The value of  $K$  for which the system just become unstable is

- (A)  $K = 6$  (B)  $K = 4$   
(C)  $K = 24$  (D)  $K = 48$

f. In  $G(s)H(s)$  plane the Nyquist plot from  $\omega = -0$  to  $\omega = +0$  is closed through an angle

- (A)  $n\pi$  (B)  $2n\pi$   
(C)  $n\pi/2$  (D)  $-n\pi$

- g. The overall transfer function for the SFG given is



- (A)  $\frac{G_1 G_2}{1 - G_1 G_2 H_1 + G_2 H_2}$       (B)  $\frac{G_1 G_2}{1 + G_1 G_2 H_1 + G_2 H_2}$
- (C)  $\frac{G_1 G_2}{1 - G_1 G_2 H_1 - G_2 H_2}$       (D)  $\frac{G_1 G_2}{1 + G_1 G_2 H_1 + G_2 H_1}$
- h. The intersection of the asymptotes of root locus having  $G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2+5s+6)}$  is given by
- (A)  $s = +1$       (B)  $s = -1$   
 (C)  $s = -5$       (D)  $s = -6$
- i. As  $K$  approaches infinity the root loci are asymptotic to lines which make an angle with real axis given by
- (A)  $\frac{2k\pi}{p-z}$       (B)  $\frac{(2k+1)\pi}{p-z}$   
 (C)  $\frac{(k+1)\pi}{p-z}$       (D)  $\frac{(2k+1)\pi}{p-z} \times \frac{\pi}{2}$
- j. The phase angle for the transfer function  $G(j\omega) = \frac{1}{(1+j\omega T)^2}$  at corner frequency is
- (A)  $45^\circ$       (B)  $-45^\circ$   
 (C)  $-90^\circ$       (D)  $90^\circ$

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

- Q.2** a. Differentiate between open loop and closed loop systems. (4)  
 b. Differentiate between Analog and Digital Control Systems. (4)  
 c. Explain servomechanism in detail with suitable diagrams. (8)
- Q.3** a. Find  $F(0+)$ ,  $F'(0+)$  and  $F''(0+)$  for the function whose Laplace Transform is given below: (8)  

$$F(s) = \frac{4s+1}{s(s^2+2)}$$
  
 b. Derive time response of a first order control system which is subjected to unit step input function. (8)
- Q.4** a. The forward transfer function of a unity feedback control system is given by (8)  

$$G(s) = \frac{K}{(s^2+3s+2)(s^2+6s+24)}$$
  
 Determine the limiting value of  $K$  for stability. (8)

- b. Calculate C/R for the block diagram shown in figure 1 using block diagram reduction method. (8)

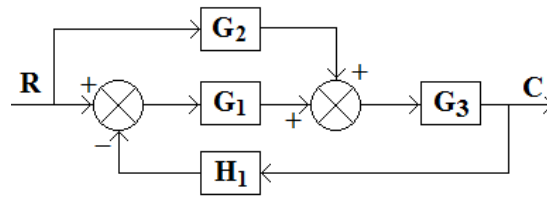


Figure 1

- Q.5 For the given block diagram in Fig.2, determine the transfer function C/R by first drawing signal flow graph and then using Mason's gain formula (16)

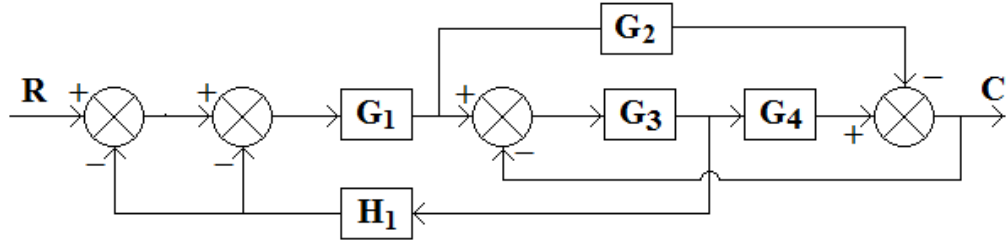


Figure 2

- Q.6 Derive values of Position, velocity and acceleration error constants for type 0, type 1 and type 2 systems. (16)

- Q.7 Use Nyquist Plot approach to determine the gain margin for a unity feedback control system having open loop transfer function given as

$$G(s) = \frac{K}{s(sT_1 + 1)(sT_2 + 1)} \text{ where } K, T_1 \text{ and } T_2 \text{ are positive. (16)}$$

- Q.8 Draw the root locus plot for a system having open loop transfer function as

$$G(s)H(s) = \frac{K}{s(s+1)(s+3)}. \text{ Determine}$$

- (i) Breakaway point (ii) Value of K for marginal stability (16)  
 (iii) Gain Margin and Phase Margin for K=6

- Q.9 a. Determine the transfer function for the Bode plot shown in Fig 3. (8)

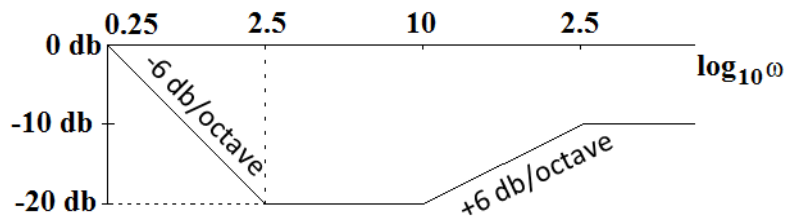


Figure 3

- b. The open loop transfer function of a feedback control system is given by

$$G(s)H(s) = \frac{K}{(s+1)(2s+1)(3s+1)}$$

- Find the value of K such that G.M is 20db using bode plot analysis method. (8)