Code: D-15 **Subject: CONTROL ENGINEERING**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x8)

a. The D.C. gain of a system represented by the transfer function $G(s) = \frac{15}{(s+0.5)(s+6)}$ is

(A) 6 **(B)** 8
(C) 3 **(D)** 5

b. The 5% settling time of a second order system with a damping ratio of 0.4 and a natural frequency of 5 rad/sec is _____

(A) 2.5 **(B)** 1.5
(C) 3.0 **(D)** 4.2

c. If the Laplace transform of f(t) is F(s), then the Laplace transform of $f(t-t_0)$ will be

(A) $F\frac{(s-t_0)}{e^{st_0}}$ **(B)** $e^{st_0}F(s)$
(C) $e^{-st_0}F(s)$ **(D)** $e^{-st_0}F\left(\frac{s}{t_0}\right)$

d. The main assumption that is made in a two-phase a.c. servomotor is that___

(A) the torque varies linearly w.r.t. the control voltage e_c.
(B) the speed varies inversely w.r.t. the control voltage e_c.
(C) the torque varies linearly w.r.t. the speed.
(D) The torque varies inversely w.r.t. the speed.

e. A high value of bandwidth for the standard second order system is an indication that _____.

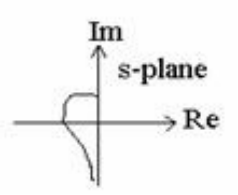
(A) the time to reach the first peak is small.
(B) the system is highly damped.
(C) the time to reach the first peak is very large.
(D) the time to reach the first peak is exact equal to zero.

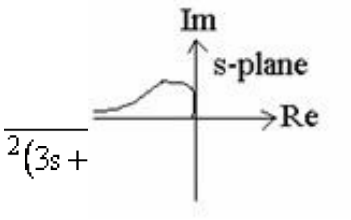
f. The steady state error with a step input for a unit feedback system with $G(s)=\frac{10}{s^2(s+4)}$ will be _____.

(A) 0 **(B)** 2
(C) 4 **(D)** 2.5

g. The asymptotic Bode plot of a system with $G(s)=\frac{10}{s(s+2)}$ shows that the gain margin for the system will be_____.

(A) 0 **(B)** ∞
(C) 10 **(D)** 5

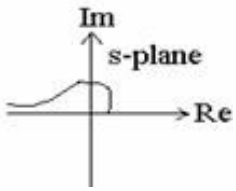


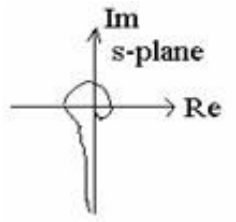


____.

(A) **(B)**

(C)





PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. Distinguish between the following pairs:
(i) Static and dynamic systems.
(ii) Closed loop and open loop systems.
(iii) Linear and non-linear system. **(6)**

b. Draw the schematic-cum-circuit diagram of a field controlled DC servomotor and derive its transfer function. **(8)**

Q.3 a. Define: state, state trajectory, state space and state transition matrix. **(4)**

b. Given a transfer function of the form:

$\frac{C(s)}{R(s)} = \frac{s^2 + a_1 s + a_2}{s^3 + b_1 s^2 + b_2 s + b_3}$ Show how it can be converted into a state variable form. Also comment whether this representation is unique. **(10)**

Q.4 a. The characteristic equation of a certain system is given as

$F(s) = 4s^3 + 2(1-3s)(1-s) + K(s+0.6) = 0$

If the permissible range of K is $0 \le K \le 3.5$, examine by the Routh-Hurwitz criterion whether or not the system will have the K in the above range. **(8)**

b. Give the schematic of a gyroscope and explain its operation. **(6)**

Q.5 a. Using force-voltage analogy give the quivalent mechanical network for the electrical network given in Fig.1 **(10)**

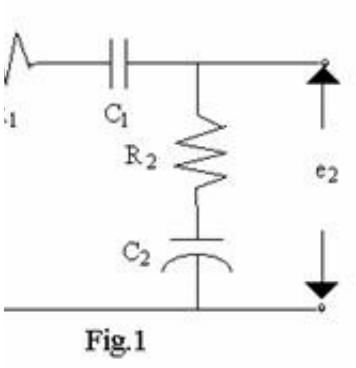
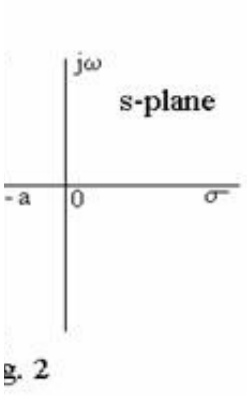


Fig.1

b. Explain how root/roots to the left of an axis parallel to the imaginary axis, can be determined as shown in Fig.2, using the Routh-Hurwitz criterion. **(4)**



g. 2

Q.6 Obtain the transfer function for a system, whose signal flow diagram is shown in Fig 3, using Mason's Gain formula.
(14)

(14)