ROLL NO. _____

Code: DE65 **Subject: CONTROL ENGINEERING**

DipIETE – ET (Current Scheme)

Time: 3 Hours **JUNE 2016** **Max. Marks: 100**

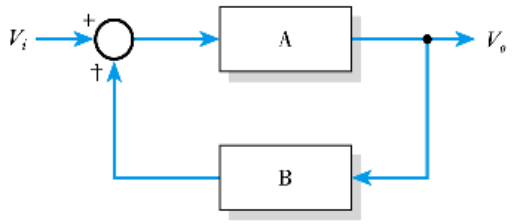
PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.**
- **Graph Sheet & Bode Plot to be provided to the students.**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. The overall transfer function of the following arrangement is given by:



(A) $(1-AB)/A$ **(B)** $A/(1+AB)$
(C) $(1+AB)/A$ **(D)** $A/(1-AB)$

b. The unit impulse response of a second order under-damped system starting from rest is given by

$$\mathbf{c(t) = 12.5\, e^{-6t} \sin 8\, t}$$

The steady-state value of the unit step response of the system is equal to

(A) 1.0 **(B)** 0.5
(C) 0.25 **(D)** 0

c. The Laplace transform of $e^{at}\sin(2\omega t)$ is

(A) $\dfrac{2\omega}{(s-a)^2+4\omega^2}$ **(B)** $\dfrac{2\omega}{(s-a)^2+2\omega^2}$

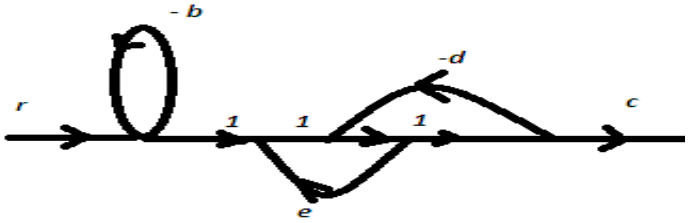
(C) $\dfrac{2\omega}{(s+a)^2+4\omega^2}$ **(D)** $\dfrac{2\omega}{(s+a)^2+2\omega^2}$

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

(A) $\frac{5}{\sqrt{2}}\sin\sqrt{2}t$ **(B)** $\frac{5}{2}\cos 2t$

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

e. The overall transmittance (c / r) of the SFG shown in Fig.1, is



(A) $\frac{1}{1+e-d+b(1+d-e)}$ **(B)** $\frac{1}{1+e-d-b(1-d+e)}$

(C) $\frac{1}{1-be+bd+(b+d-e)}$ **(D)** $\frac{1}{1+e-d+b(1-d+e)}$

f. The initial response of a control system when output is not equal to input is called

(A) Dynamic response **(B)** Transient response

(C) Steady state response **(D)** Impulse response

g. A unity feedback system with open-loop transfer function $G(s)=\frac{3}{2[s(s+c)]}$ is critically damped. The value of the parameter 'c' is

(A) 3/2 **(B)** 3
(C) 2 **(D)** 1

h. The value of position and velocity error constant for type '2' system are

(A) Constant, constant **(B)** Constant, infinity
(C) Zero, constant **(D)** Zero, zero

i. The first two rows of Routh's tabulation of a third order equation are as follows.

s^3	2	2
s^2	4	4

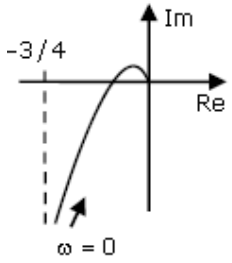
This means that the system is
(A) Stable **(B)** Unstable
(C) Marginally stable **(D)** Conditionally stable

j. The frequency response plot of

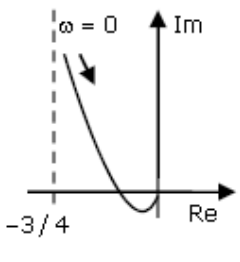
$$G(s) = \frac{1}{[s(s+1)(s+2)]}$$

in the complex G(jω) plane for 0< ω<∞ is

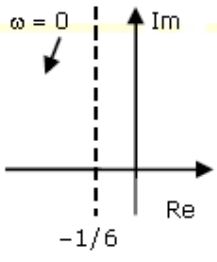
(A)



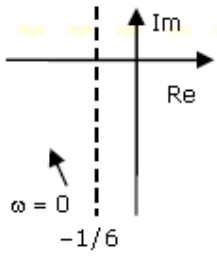
(B)



(C)



(D)



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

Q.2 a. Define feedback and the various components involved in a feedback control system. Why is negative feedback invariably preferred in a closed loop systems? **(8)**

b. Define a control system with a neat sketch and also explain the operation of a servomechanism.. **(8)**

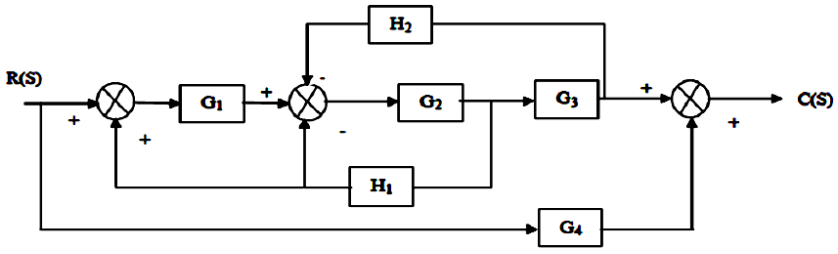
Q.3 a. Find the solution of initial-value problem **(8)**

$$x^2 y' + xy = 1$$
$$x > 0$$
$$y(1) = 2$$

b. Find the inverse Laplace Transform of F(s) **(8)**

$$F(s) = \frac{3s^2 + 10s + 10}{s^3 + 4s^2 + 6s + 4}$$

Q.4 a. Obtain the closed loop transfer function C(s)/R(s) of the system whose block diagram is shown in fig. **(8)**

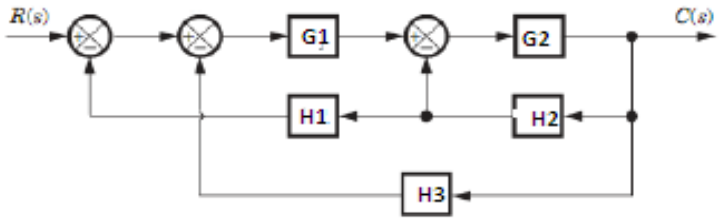


b. Using Routh Hurwitz criteria, find whether the closed loop control system defined by the characteristic equation P(s) is stable or not? **(8)**

$$P(s) = s^4 + s^3 + s^2 + s + 3$$

Q.5 a. What is a Signal Flow Graph? Explain Mason's gain formula for obtaining the overall transfer function through Signal Flow graph. (8)

b. Obtain the Signal Flow Graph of the given block diagram and the overall transmittance C(s)/R(s). **(8)**



Q.6 a. Obtain the value of static error constants and the respective steady state errors for type '0', '1' and '2'system when subjected to unit step, unit ramp and unit parabolic input. **(8)**

b. Determine the response θ(t) for the system, whose transfer function is given as $\frac{\theta(s)}{R(s)} = \frac{2.25}{s^2 + 0.5s + 2.25}$ when subjected to unit step input. Also find rise time, peak time, peak overshoot and settling time. **(8)**

Q.7 a. Draw the polar plot for given transfer function **(6)**

$$G(s)H(s) = \frac{s}{s-1}$$

b. What is Nyquist criterion? Draw the Nyquist plot for the given open loop transfer function and determine the stability.

$$G(s)H(s) = \frac{5}{s^2(s+9)}$$ **(10)**

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. Write the general guidelines for sketching the root locus of a control system. **(6)**

Q.9 a. What is the benefit of drawing Bode plot on a semilog scale? **(6)**

b. Draw the Bode plot for given open loop transfer function and determine the gain margin and phase. State whether the system is stable or not? **(10)**

$$G(s)H(s) = \frac{50}{s(s+1)(s+100)}$$