**Code: DE15** **Subject: CONTROL ENGINE**
**Time: 3 Hours** **Max. Mark**

# JUNE 2011

**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.**

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

a. Which of the following statement is not true for root locus technique?

**(A)** It is used to obtain closed-loop pole configuration from open-loop poles and zeros.
**(B)** It is most useful for single-input single-output systems
**(C)** It provides the pattern of movement of closed-loop poles when open-loop gain varies
**(D)** None of these

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

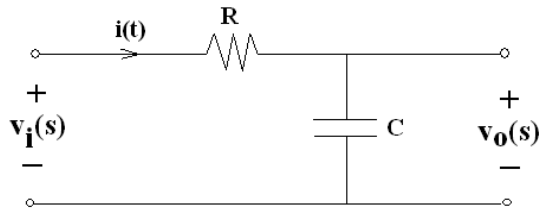


Fig. 1

**(A)** $\dfrac{RC}{s+\dfrac{1}{RC}}$ **(B)** $\dfrac{\dfrac{1}{RC}}{s+RC}$

**(C)** $\dfrac{\dfrac{1}{RC}}{s+\dfrac{1}{RC}}$ **(D)** $\dfrac{1}{s+\dfrac{1}{RC}}$

c. Laplace transform of damped cosine wave $e^{-at}\cos\omega t$ is

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

**(C)** $\dfrac{s}{(s+a)^2+\omega^2}$ **(D)** $\dfrac{1}{(s+a)^2+\omega^2}$

d. In force-voltage analogy, mass is analogous to

**(A)** Voltage **(B)** Inductance
**(C)** Resistance **(D)** Capacitance

e. The damped natural frequency of an under damped second –order system is given by

**(A)** $\omega_d = \omega_n$ **(B)** $\omega_d = \xi\omega_n$
**(C)** $\omega_n = \omega_d\sqrt{1-\xi^2}$ **(D)** $\omega_d = \omega_n\sqrt{1-\xi^2}$

f. Gain cross-over frequency is defined as

**(A)** $|G(j\omega)H(j\omega)| = 1$ **(B)** $|G(j\omega)H(j\omega)| = 0$
**(C)** $|G(j\omega)H(j\omega)| = \infty$ **(D)** $|G(j\omega)H(j\omega)| = \frac{1}{\sqrt{2}}$

g. The value of K for which the system $s^3 + 3s^2 + 3s + 1 + K = 0$ becomes stable is

**(A)** K>8 **(B)** K=8
**(C)** K=7 **(D)** None of these

h. The transfer impedance is defined as

**(A)** The ratio of transform voltage to transform current at the same part
**(B)** The ratio of transform voltage at one part to the current transform at the other part
**(C)** Both **(A)** and **(B)**
**(D)** None of these

i. The steady state error of a stable type 0 unity feedback system for a unit step function is: where $K_p$ is the position error constant.

**(A)** 0 **(B)** $\frac{1}{1+K_p}$
**(C)** $\infty$ **(D)** $\frac{1}{K_p}$

j. The number of roots of $s^3+5s^2+7s+3=0$, in the left half of the s-plane is:

**(A)** zero **(B)** one
**(C)** two **(D)** three

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

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**Q. 2** a. Write the differential equations describing the dynamics of the system as shown in Fig. 2. Find the ratio $\frac{X_2(s)}{F(s)}$ **(8)**

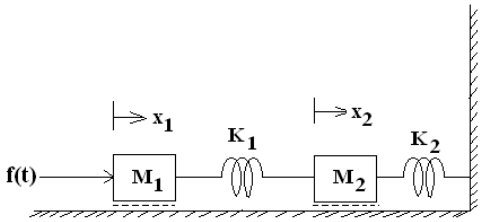


Fig. 2

b. Find the transfer function of lag network as shown in Fig. 3 **(8)**

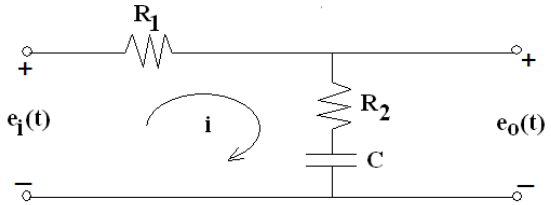


Fig. 3

**Q. 3** a. Reduce the block diagram shown in Fig.4 to the simplest form and obtain its closed loop transfer function. **(8)**

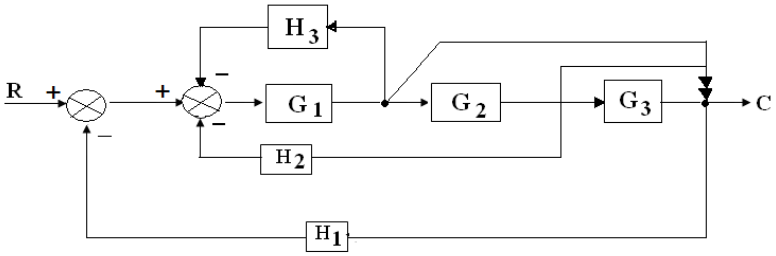


Fig. 4

b. Explain the characteristics of LVDT and derive the expression for its transfer function. **(8)**

**Q. 4** a. Discuss the effect of feedback on: (i) Overall gain (ii) Stability (iii) Sensitivity **(8)**

b. Explain Derivative feedback control. **(8)**

**Q. 5** a. For a single loop feedback control system

$G(s) = \dfrac{1}{s^2(s+12)}$ and $H(s) = \dfrac{5(s+1)}{(s+5)}$. Evaluate the steady state errors for three basic types of inputs, unit step, unit ramp and unit parabola. **(6)**

b. Consider the closed-loop control system as shown in Fig. 5. Sketch the root loci diagram of the system for $0 \le K < \infty$ . Show the following on the sketch: (i) asymptotes of root loci as $s \to \infty$ (ii) intersection of the asymptotes. **(10)**

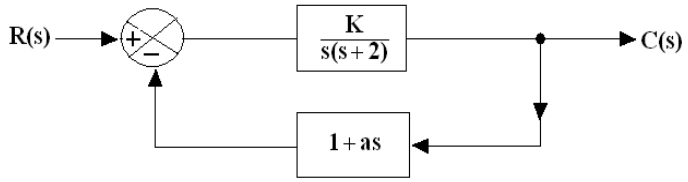


Fig. 5

**Q. 6** a. Draw the Bode plot for the transfer function $G(s) = \frac{50}{s(1+0.25s)(1+0.1s)}$.

From the graph determine:
(i) Gain crossover frequency (ii) Phase crossover frequency
(iii) GM and PM (iv) Stability of the system **(10)**

b. Discuss the following: (i) Nichol's chart (ii) Phase margin and gain margin. **(6)**

**Q.7** a. A unity feedback system has open loop transfer function $G(s) = \frac{1}{2(1+2s)(1+s)}$. Sketch Nyquist plot for the system and therefore obtain the gain margin and the phase margin **(8)**

b. What is a phase lead network? Calculate the transfer function and draw the Bode plot. **(8)**

**Q.8** a. The characteristic equation of a feedback system is $s^4+20ks^3+5s^2+(10+k)s+15=0$. Determine k for stable system. **(8)**

b. Write short notes on Passive electric networks. **(8)**

**Q. 9** a. Obtain C/R ratio of a system whose signal flow graph is represented in Fig.6. **(8)**

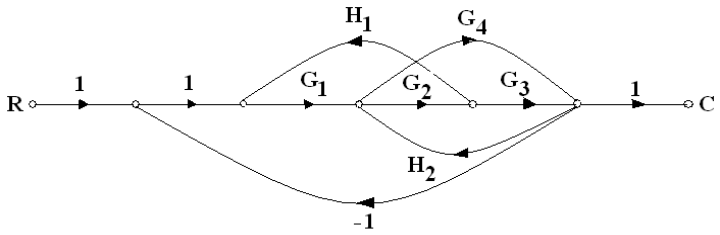


**Fig.6**

b. Write notes on: **(8)**
(i) Op-amp as proportional & integral.
(ii) Op-amp as proportional, integral & derivative.