Registration No. : | | | | | | | | | | |

*Total number of printed pages – 4*

**B. Tech**

**PCEC 4303**

# Fifth Semester Examination – 2013

## CONTROL SYSTEM ENGINEERING

**BRANCH : ELECTRICAL, EEE**

**QUESTION CODE : C-336**

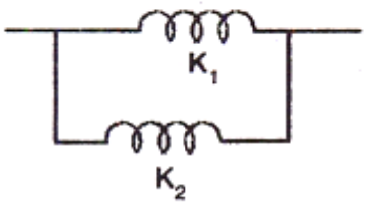
**Full Marks – 70**

**Time : 3 Hours**

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
*The figures in the right-hand margin indicate marks.*

1. Answer the following questions : 2×10

(a) Determine the equivalent spring constant for the given system.






(b) Determine the transfer function of the system described by

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

(c) Say with reasons, which of the following differential equations is time-invariant.

(i) $\left(\frac{1}{t+1}\right)d^2y/dt^2+\left(\frac{1}{t+1}\right)y=0$

(ii) $\frac{d}{dt}(t^2y)=0$

(iii) $d^2y/dt^2+(\cos t)\,y=0$

P.T.O.

(d) The closed-loop transfer function of a control system is given by

$$\frac{C(s)}{R(s)} = \frac{1}{1+s}$$

For the input r(t) = sint, determine the steady state response c(t).

(e) The open-loop transfer function of a feedback control system is

$$\frac{K}{s(s^2+3s+6)}$$

Determine the breakaway point(s) of the root locus plot if it exists.

(f) Compare between the gain and phase margins of two closed-loop systems having loop transfer functions G(s) H(s) and $e^{-s}$G(s) H(s).

(g) The polar plot of $G(s)=\frac{10}{s(s+1)^2}$ intersects the real axis at $\omega=\omega_0$. Determine the real part and $\omega_0$.

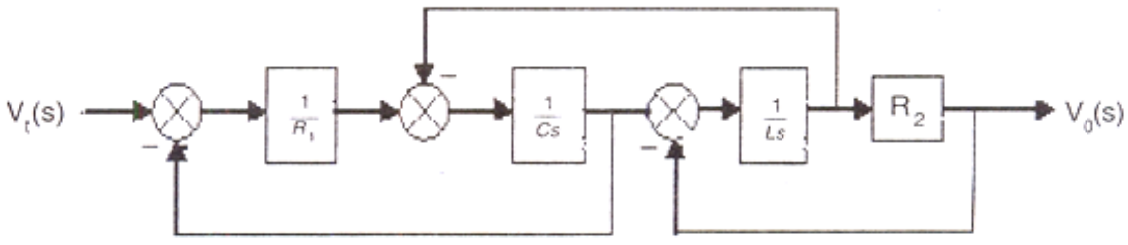


(h) Write down the criteria to be fulfilled by a point to be on the root locus. Give reasons for your answer.

(i) A unity feedback system has the forward path transfer function $(s)H(s)=\frac{16}{s(s+4)}$. What are the resonant frequency and damped natural frequency of the closed-loop frequency response system in rad/sec ?

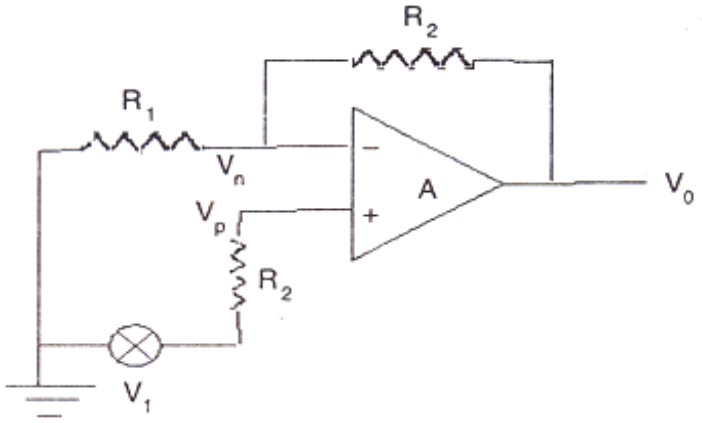
(j) Describe the effects of Derivative and Integral control actions.

2. (a) For the system shown in figure, find the transfer function $V_0(s)/V_i(s)$ from its signal flow graph. 5




(b) Enumerate the effect of negative feedback on system sensitivity, bandwidth and speed of response. 5

3. Find the transfer function of the non-inverting operational amplifier shown in figure. 10




4. The open-loop transfer function of a unity negative feedback system is

$$G(s)=\frac{K}{s(as+1)}$$

By what factor is the gain K to be changed so that the peak overshoot is reduced from 25% to 16% ? Also, find the factor by which the constant a is to be changed so as to reduce the damping ratio from 0.75 to 0.6. 10



5. (a) A unity feedback control system has the closed-loop transfer function

$$T(s)=\frac{as+K}{s^2+bs+K}$$

Show that the steady state error is zero for a unit ramp input, if a = b. 5

(b) The closed loop transfer function of a system is

$$\frac{C(s)}{R(s)}=\frac{100}{(s^6+3s^5+8s^4+18s^2+20s^2+24s+16)}$$

Determine the number of poles on the RHP, LHP and on the $j\omega$ axis and comment on the stability of the system. 5

6. (a) The open-loop transfer function of a system is given by

$$G(s)H(s)=\frac{k}{(s+1)^2}$$

Show the branches of the root locus, break-away and break-in points and imaginary axis cross-over points. 5

(b) Define the following terms : 5

(i) Nyquist Stability criteria

(ii) Gain margin

(iii) Phase margin.

7. (a) Sketch the approximate Bode Plot for $G(s) = \frac{K(1+5s)}{s^2(1+0.5s)}$. 5

(b) Draw Polar Plot for $G(s) = \frac{1}{s(1+sT)}$. 5

8. Write short notes on any **two** of the following : 5×2

(a) Gear Train

(b) AC Servomotor

(c) Error Constants

(d) Constant M- circles.