Code: DE15 **Subject: CONTROL ENGINEER**

Time: 3 Hours **DECEMBER 2010** **Max. Marks: 1**

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 half an hour 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.**

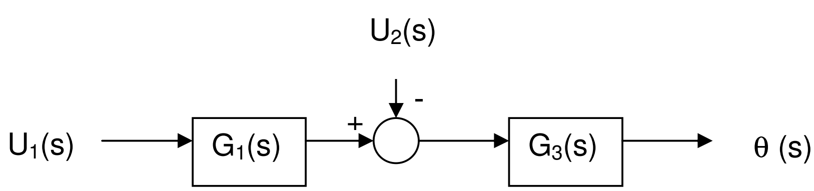
Q.1 Choose the correct or best alternative in the following: **(2 × 10)**

a. The dead time model $e^{-s\tau_D}$ may be approximated by the transfer function

(A) $\dfrac{1-\frac{\tau_D}{2}s}{1+\frac{\tau_D}{2}s}$ **(B)** $\dfrac{1+\frac{\tau_D}{2}s}{1-\frac{\tau_D}{2}s}$

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

b. In the block diagram shown below, the output $\theta(s)$ is equal to



(A) $U_1(s)+U_2(s)$ **(B)** $U_1(s)G_1(s)+U_2(s)G_3(s)$

(C) $U_1(s)G_1(s)G_3(s)-U_2(s)G_3(s)$ **(D)** $U_1(s)G_1(s)-U_2(s)G_3(s)$

c. If the system has multiple poles on jω axis, the system is

(A) Stable **(B)** Unstable

(C) Marginaly stable **(D)** Conditionally stable

d. The describing equation of the mass-damper-spring system is given by

$$2\frac{d^2x}{dt^2}+\frac{dx}{dt}+0.5x=f(t)\ ,$$

Where *f(t)* is external force acting on the system and *x* is the displacement of the mass. The steady state displacement to a force 2 Newton is given by

(A) 4m **(B)** 0.5m

(C) 2m **(D)** 0.25m

e. A unity feedback system has open-loop transfer function G(s). The steady-s… error is zero for

(A) step input and type-1 G(s)
(B) ramp input and type-1 G(s)
(C) step input and type-0 G(s)
(D) ramp input and type-0 G(s)

f. Integral error compensation in a control system

(A) Minimizes steady state error
(B) Increases steady state error
(C) Improves transient response
(D) none of these

g. For converting the angular position of a shaft which of the following transducer can be used

(A) LVDT
(B) Synchro
(C) Thermocouple
(D) AC servomotor

h. A unity feedback system has an open loop transfer function $G(s) = \dfrac{K}{s(s^2 + 4s + 13)}$. The centroid of the asymptotes of the root locus plot lies at

(A) -4
(B) -4/3
(C) 4
(D) -13

i. The undamped natural frequency ω_n and resonant frequency ω_r of a second order system with damping ratio less than 0.7, are related

(A) $\omega_n = \omega_r$
(B) $\omega_n > \omega_r$
(C) $\omega_n < \omega_r$
(D) none of these

j. With feedback __________ increases.

(A) system stability
(B) system gain
(C) system accuracy
(D) All of the above

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

Q. 2 a. The transfer function of a first order process is given by

$$\frac{Y(s)}{R(s)} = G(s) = \frac{K}{\tau s + 1} \quad \text{where } \tau \text{ is the time constant of the system}$$

(a) Find the impulse response to an impulse of strength A.
(b) Find the step response to a step of strength A
(c) Find the ramp response to ramp function of slope A.

Identify the steady state and transient components of resp
in each case.

b. Draw the basic structure of the feedback control system. Name the parts of it and explain the function of each part briefly. **(4)**

Q. 3 a. Reduce the block diagram shown in Fig.1 below and obtain the transfer function. **(10)**

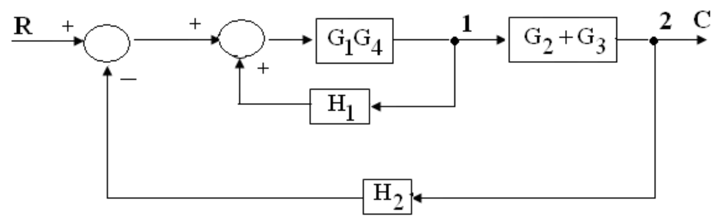


Fig.1

b. Explain with neat sketches the construction and working of ac servo motor. **(6)**

Q. 4 For the unity feedback system shown below, obtain (i) the closed loop transfer function, (ii) damping ratio,(iii) natural frequency, (iv) rise time , (v) peak time (vi) settling time and (vii) steady state error and (viii) % peak overshoot, if subjected to unit step input. **(16)**

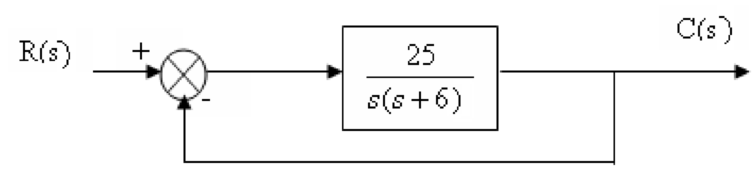


Fig.2

Q. 5 a. A unity feedback control system has an open loop pole transfer function given as $G(s)=\dfrac{K(s^2+5s+6)}{s(s+1)}$; $K \geq 0$. Make rough sketch of root locus plot, explicitly identifying the centroid, the asymptotes, and the breakaway points. **(10)**

b. Discuss the effect of system- type 0, type I and type II for unit step input on steady state error constants. **(6)**

Q. 6 Draw the Bode plot for the following transfer function $GH(s)=\dfrac{80}{s(s+2)(s+20)}$ Determine the stability margins. **(16)**

Q.7 a. Using Nyquist Criterion determine the stability of the close loop sys having the open loop transfer function $GH(s) = \frac{s+2}{s^2}$. (

b. What is Nichols chart? How can we identify resonance peak and bandwidth from Nichols chart? **(8)**

Q. 8 a. The transfer function of a lag-lead compensator is given by

$$D(s) = \left(\frac{\tau_1 s + 1}{\beta \tau_1 s + 1}\right)\left(\frac{\tau_2 s + 1}{\alpha \tau_2 s + 1}\right) \qquad \beta > 1,\ \alpha < 1, \tau_1, \tau_2 > 0$$

Give an op-amp circuit that realizes this D(s). **(8)**

b. Explain the tuning of PID controller used for controlling industrial processes. **(8)**

Q. 9 a. Consider the closed –loop system shown in Fig.3. Determine the range of K for which the system is stable. **(8)**

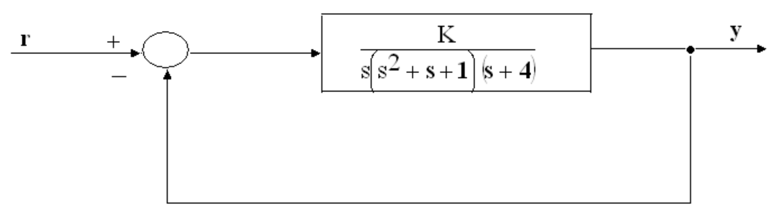


Fig. 3

b. Write notes on: **(8)**

(i) Modes of feedback control

(ii) Lead and Lag Compensation