

DipIETE – ET (OLD SCHEME)

Code: DE15
Time: 3 Hours

Subject: CONTROL ENGINEERING
Max. Marks: 100

DECEMBER 2010

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

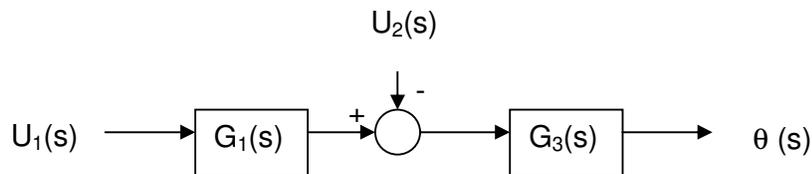
(A) $\frac{1 - \frac{\tau_D}{2}s}{1 + \frac{\tau_D}{2}s}$

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

(C) $\frac{1 - \tau_D s}{1 + \tau_D s}$

(D) $\frac{1 + \tau_D s}{1 - \tau_D s}$

- 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 $j\omega$ axis, the system is

(A) Stable

(B) Unstable

(C) Marginally 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

Identify the steady state and transient components of response in each case. (12)

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)

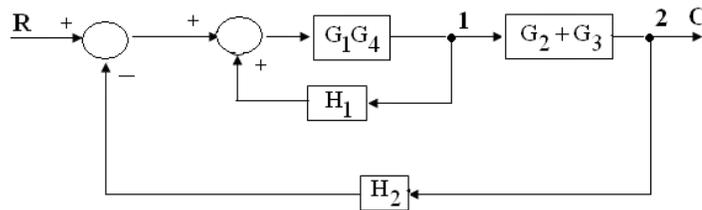


Fig.1

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)

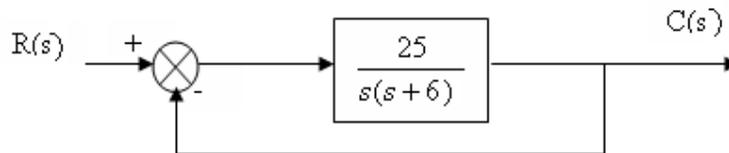


Fig.2

Q. 5 a. A unity feedback control system has an open loop pole transfer function given as $G(s) = \frac{K(s^2 + 5s + 6)}{s(s+1)}$; $K \geq 0$. 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 $GH(s) = \frac{80}{s(s+2)(s+20)}$ Determine the stability margins. (16)

- Q.7** a. Using Nyquist Criterion determine the stability of the close loop system having the open loop transfer function $GH(s) = \frac{s+2}{s^2}$. (8)
- 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
- $$D(s) = \left(\frac{\tau_1 s + 1}{\beta \tau_1 s + 1} \right) \left(\frac{\tau_2 s + 1}{\alpha \tau_2 s + 1} \right) \quad \beta > 1, \alpha < 1, \tau_1, \tau_2 > 0$$
- 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)

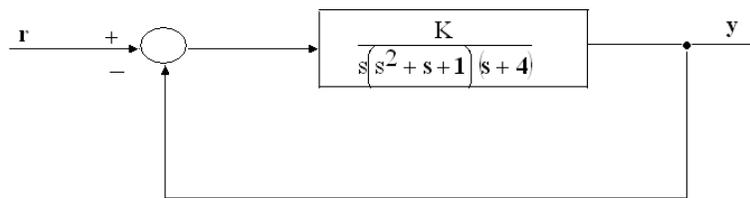


Fig.3

- b. Write notes on: (8)
- (i) Modes of feedback control
 - (ii) Lead and Lag Compensation