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BAS-020

00160

B.TECH. (AEROSPACE ENGINEERING) (BTAE)

Term-End Examination

June, 2013

BAS-020 : BASIC CONTROL THEORY

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **seven** question in **all**. Question no.1 **compulsory**. Use of scientific calculator is **permitted**. **All** questions carry **equal** marks.*

1. Choose the correct or best answer in the following : **5x2=10**

(a) Closed-loop transfer function of a unity-feed back system is given by

$\frac{Y(s)}{R(s)} = \frac{1}{(\tau s + 1)}$. Steady state error to unit-ramp input is :

(i) ∞

(ii) τ

(iii) 1

(iv) $1/\tau$

(b) Electrical time constant of an armature controlled dc servomotor is :

(i) equal to mechanical time constant

(ii) smaller than mechanical time constant

(iii) larger than mechanical time constant

(iv) none of the above

(c) Peak overshoot of step-input response of an underdamped second-order system is explicitly indicative of :

(i) settling time

(ii) rise time

(iii) natural frequency

(iv) damping ratio

(d) A type-1 plant is changed to type-2 feedback system by the following cascade control action :

(i) PD

(ii) PI

(iii) Either PD or PI

(iv) Neither PD nor PI

(e) A unity feedback system has open-loop transfer function $G(s) = \frac{K}{[s(1 + s\tau)]}$.

(i) ∞

(ii) 0

(iii) 1

(iv) none of the above

2. Given the transfer function 10

$$G(s) = \frac{Y(s)}{R(s)} = \frac{1}{s^2 + 3s + 2}$$

Find the response $y(t)$ to the input

(a) $r(t) = 5u(t)$

(b) $r(t) = 5tu(t)$

Find the steady-state component y_{ss} of $y(t)$ in each case.

3. Obtain the roots of given characteristic polynomial on the basis of the Routh's array : 10

(a) $s^4 + 2s^3 + 11s^2 + 18s + 18 = 0$

(b) $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$

4. A unity-feedback system has open-loop transfer function 10

$$G(s) = \frac{Wn^2}{s(s + 2\zeta Wn)} ; (\zeta < 1)$$

Derive expressions for peak overshoot Mp and peak time tp of the time response of the given system to unit-step input.

5. Consider a unity-feedback system with a forward path transfer function 10

$$G(s) = \frac{K(s + 3)}{s\ (s + 2)} ; K \geq 0$$

Show that root-locus circle is the part of the root locus. Construct the root locus and determine the damping ratio for maximum oscillatory response. What is the value of K at this point of the locus ?

6. (a) Using principle of argument, derive the Nyquist's stability criterion. **5x2=10**

(b) Give an example of physical system whose transfer function model has a pole in the right-half s-plane.

7. Determine gain crossover frequency, phase crossover frequency, gain margin and phase margin of a feedback system with open loop transfer function **10**

$$G(s) = \frac{40}{(s+2)(s+4)(s+5)}$$ using bodeplots.

8. The open-loop transfer function of a control system is : **10**

$$G(s)H(s) = \frac{1}{s(1+0.5s)(1+2s)}$$

(a) Determine approximate value of gain margin and phase margin.

(b) If a lag compensator with transfer function $D(s) = \frac{K_c(1+3s)}{(1+5s)}$ is inserted in the forward path, find the value of K_c to keep the gain margin unchanged.

9. Write short notes on ***any two*** of the following :

(a) Stability **2x5=10**

(b) Proportional integral differential controller

(c) Computer electronic design aspects