53 (IE 506) CNTH

2014

CONTROL THEORY

Paper : IE 506

Full Marks : 100

Pass Marks : 30

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of seven.*

1. *(a)* What is automatic control system ? Explain it with suitable example. 10

   (b) Derive the Transfer function for Speed Control of DC motor using Field Control Method ? 10

2. *(a)* Write the differential equation governing the Mechanical rotational system shown in *Fig. 1.* Obtain the Transfer Function of the system. 10

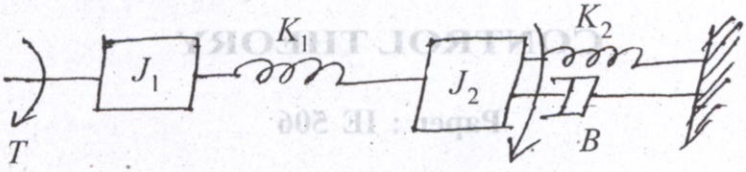

Fig. 1

(b) Derive the expression and draw the response of undamped second order system for unit step input. 10

3. Consider the speed control system in *Fig. 2*, to control the angular speed, *w* of the load. The generator field time constant is negligible and it is driven at constant speed giving a generated voltage of *kg volts/Field amp*. The generated *emf* is used to run the separately excited motor which has a back *emf* of K_b *Volts/(rad/sec)*. The motor develops a torque of K_T *N-m/amp*. The motor and its load have a combined moment of inertia of *J kg-m*^{2} and negligible friction. A Tachometer is employed for speed feedback which develops a feedback voltage of $K_t Volts/(rad/sec)$. The

desired speed is set through a potentiometer. The difference between reference voltage e_r and the feedback voltage e_t is amplified using an amplifier which produces a field current of K_A *amps/volt.*

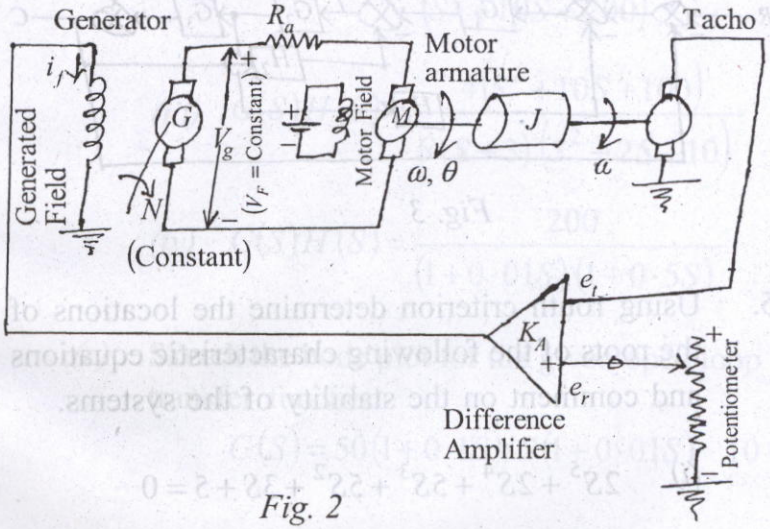

Fig. 2

Given that : $K_A = 6\ Amp/Volts$; $K_T = 2 \cdot 5\ N\text{-}m/\text{amp}$;

$K_g = 50 Volts/amp$; $K_t = 0 \cdot 2 Volt/(rad/sec)$;

$K_b = 0 \cdot 75 Volts/(rad/sec)$; $R_a = 1\Omega$; $J = 6 kg\text{-}m^2$

Draw a block diagram of the system and determine the Transfer Function $\omega(S)/E(S)$. 20

4. Using block diagram reduction technique find the Transfer Function $C(S)/R(S)$ for the system shown in *Fig. 3*. 20

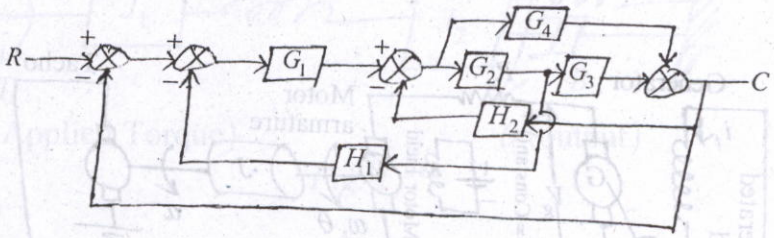

Fig. 3

5. Using routh criterion determine the locations of the roots of the following characteristic equations and comment on the stability of the systems.

(i) $2S^5 + 2S^4 + 5S^3 + 5S^2 + 3S + 5 = 0$

(ii) $S^5 + S^4 + 4S^3 + 24S^2 + 3S + 63 = 0$

2×10=20

6. *(a)* Define the term steady state error and static error constant. 6

(b) Find the type and order of the following systems — 4

(i) $G(S)H(S)=\dfrac{100}{S^2\left(S^2+4S+200\right)}$

(ii) $G(S)H(S)=\dfrac{200}{\left(S^2+10S+200\right)}$

(iii) $G(S)H(S)=\dfrac{4\left(S^2+10S+100\right)}{S(S+3)\left(S^2+2S+10\right)}$

(iv) $G(S)H(S)=\dfrac{200}{(1+0\cdot01S)(1+0\cdot5S)}$

(c) Sketch the bode plot for the given open loop transfer function

$$G(S)=50(1+0\cdot1S)/S(1+0\cdot01S)$$ 10

7. Write short note on the following : 5×4=20

(a) Time domain specifications

(b) Standard test siqual

(c) Rules to construct root locus

(d) Frequency domain specifications.
