

GUJARAT TECHNOLOGICAL UNIVERSITY**B E Sem-VI Examination May 2011****Subject code: 161905****Subject Name: Control Engineering****Date: 23/05/2011****Time: 10.30 am – 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** State whether the following statements are true or false. **07**
- (1) Sprinkler is an example of open loop control system.
 - (2) In stochastic control system the response is not predictable and repeatable.
 - (3) Servomechanism is an automatic control system.
 - (4) Human system is a single variable control system.
 - (5) Signal flow graphs are primarily useful for analyzing non-linear control system.
 - (6) Root locus is defined as the path of the roots of the transfer function traced out in the S-plane as a system parameter is changed.
 - (7) A system is unstable if all the poles of the characteristic equation are towards the left-hand side of the S-plane.
- (b)** For mechanical system shown in Fig. 1 **07**
- Write the differential equations governing the system.
 - Obtain Laplace transform of these equations.
 - Draw the Force-Voltage analogous electrical network.
- Q.2 (a)** Obtain the mathematical equation and sketch the time response of a second order control system for a unit step input (for damping factor = $\zeta < 1$). **07**
- (b)** From a given signal flow graph (Fig. 2), using Masson's gain formula deduce overall transmittance. **07**
- OR**
- (b)** Reduce block diagram as shown in Fig. 3 and obtain overall transfer function. **07**
- Q.3 (a)** Using Routh-Hurwitz criterion, determine the stability for the system having characteristic equation **07**
- $$s^5 + 2s^4 + 6s^3 + 12s^2 + 6s + 10 = 0$$
- (b)** Consider the speed control system shown in Fig. 4, to control the angular speed, ω of the load. For a given data, draw a block diagram of the system and determine the transfer function $w(s)/E_r(s)$. **07**
- Given that: $K_A = 4$ amps/volts ; $K_T = 1.5$ N-m/amp ; $K_g = 50$ volts/amp ;
 $K_t = 0.2$ volts/(rad/sec) ; $K_b = 0.75$ volts / (rad/sec) ;
 $R_a = 1\Omega$; $J = 6$ Kg-m²
- OR**
- Q.3 (a)** Draw Proportional-Derivative (PD) hydraulic controller, explain its working and determine its transfer function. **07**
- (b)** Derive the torque equation of gear-train system (Fig. 5) referred to motor shaft. **07**

Q.4 (a) Draw and explain the block diagram of PLC. Also state advantages and disadvantages of PLC system. **07**

(b) A unity feedback system has an open-loop transfer function: **07**

$$G(s) = \frac{K}{s(s+2)(s+4)}$$

Sketch the root locus and find the value of K so that the damping ratio of the closed-loop system is 0.5.

OR

Q.4 (a) (i) Draw an equivalent PLC ladder diagram for digital gate circuit shown in Fig. 6. **07**

(ii) Draw the ladder rungs to represent the following:

- Two switches that are NO and either of the switches have to be closed for a lamp to operate.
- The output Y1 is turned ON, when input X1 is closed and input X2 is open.
- When input X1 is closed, and either input X2 or X3 is open. Turn ON output Y1; otherwise it should be OFF.

(b) Define state, state vector, and state space in the context of state-space approach and obtain state model for the following transfer function **07**

$$\frac{C(s)}{R(s)} = \frac{(s+2)}{(s+1)(s+3)}$$

Q.5 (a) Draw and explain detail block diagram of fuzzy logic controller. **07**

(b) Attempt the followings: **07**

- (i) Essential elements of hydraulic circuit design
- (ii) Working of Directional Control Valve
- (iii) Functioning of boiler feed water control

OR

Q.5 (a) Suggest a design for a fuzzy control of a water heating system (Fig. 7). **07**

(b) (i) Compare between pneumatic control system and hydraulic control system **07**

(ii) Sketch and explain pneumatic nozzle-flapper amplifier.

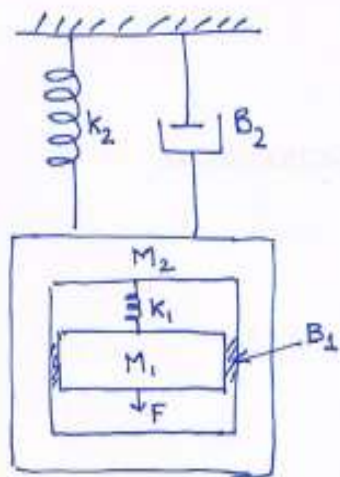


Fig. 1

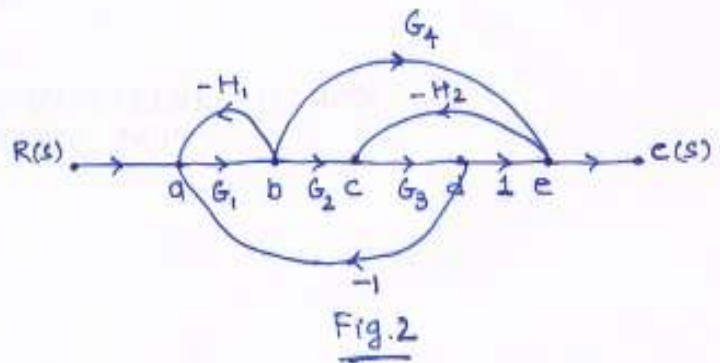


Fig. 2

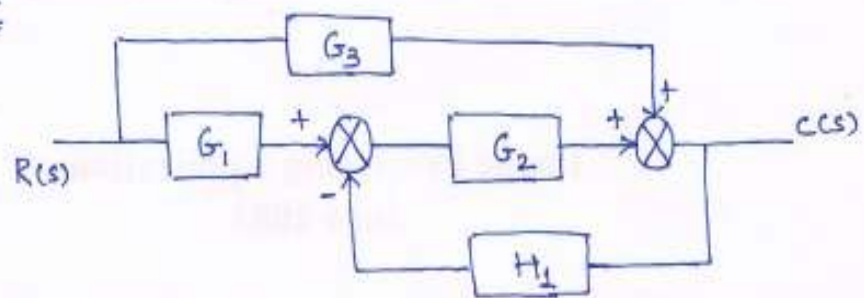


Fig. 3

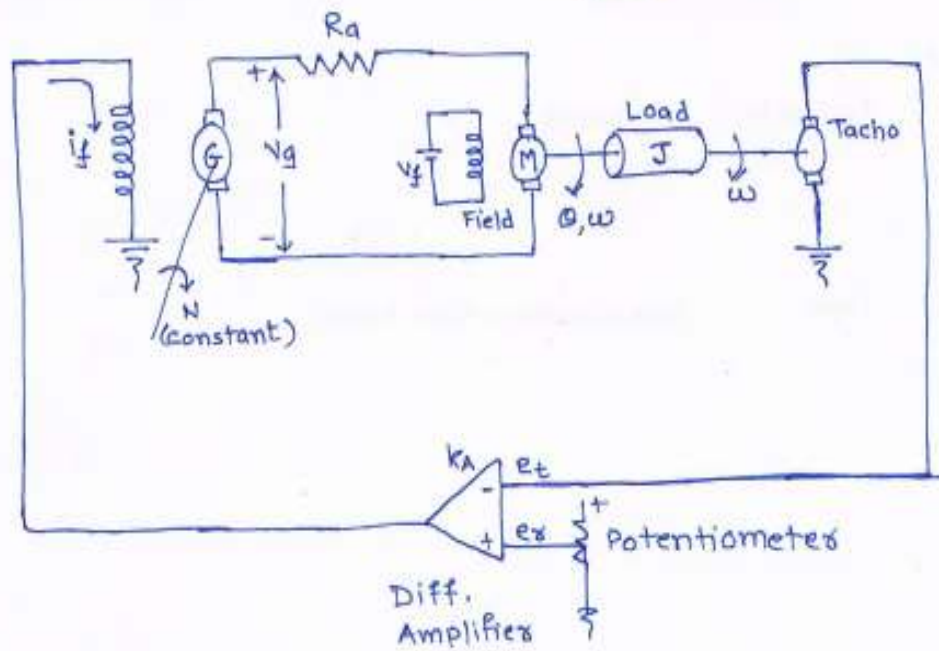


Fig. 4

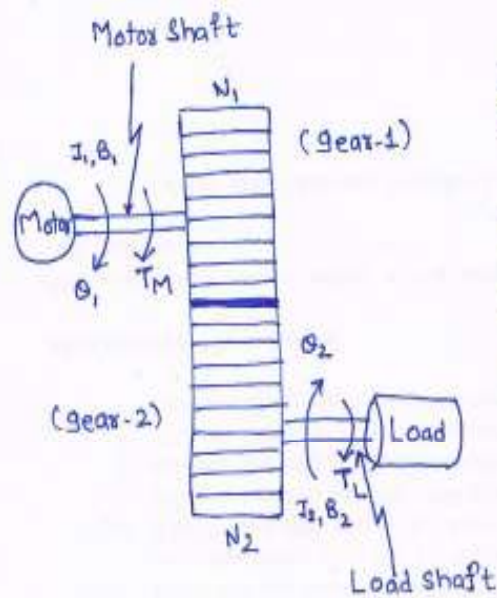


Fig. 5

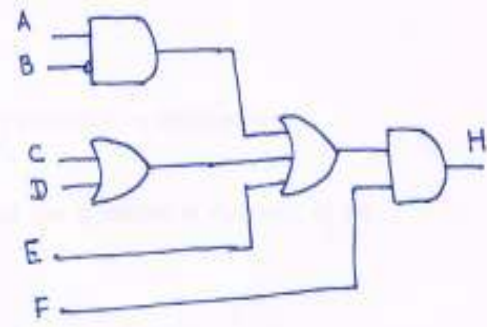
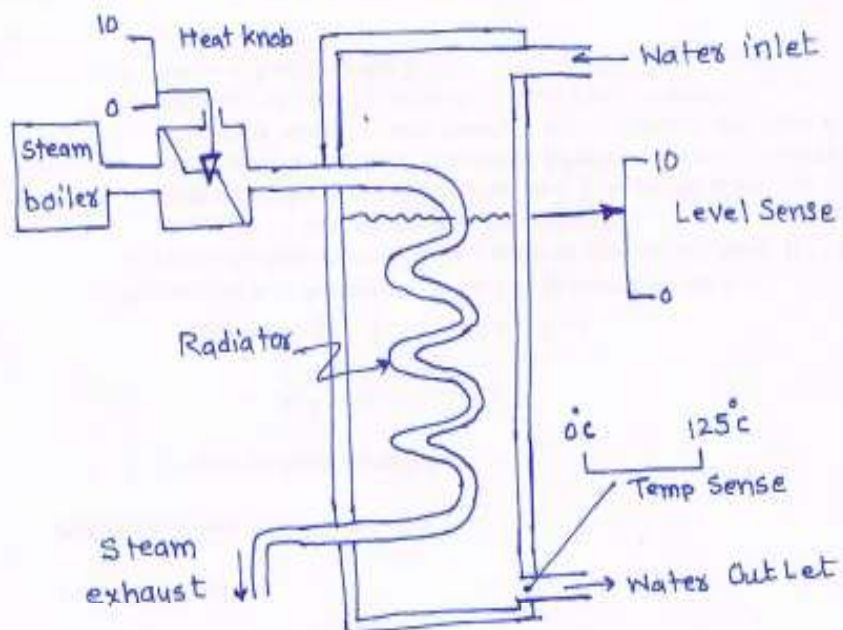


Fig. 6



Water Heating System

Fig. 7