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Set 2075 Bhadra

Chapter : 7 → 10

Q.7 Differentiate between closed-loop and open-loop control system. Draw a typical block diagram of a PID control system & describe PID tuning.

→ Def^n, stability, Accuracy, Optimization.

Open Loop CS	Closed Loop CS
1. A control system in which output doesn't depend on the feedback	1. A control system in which the output depends on feedback.
2. Less stable	2. More stable
3. Less accurate	3. More accurate
4. Optimization is not possible.	4. Optimization is possible.

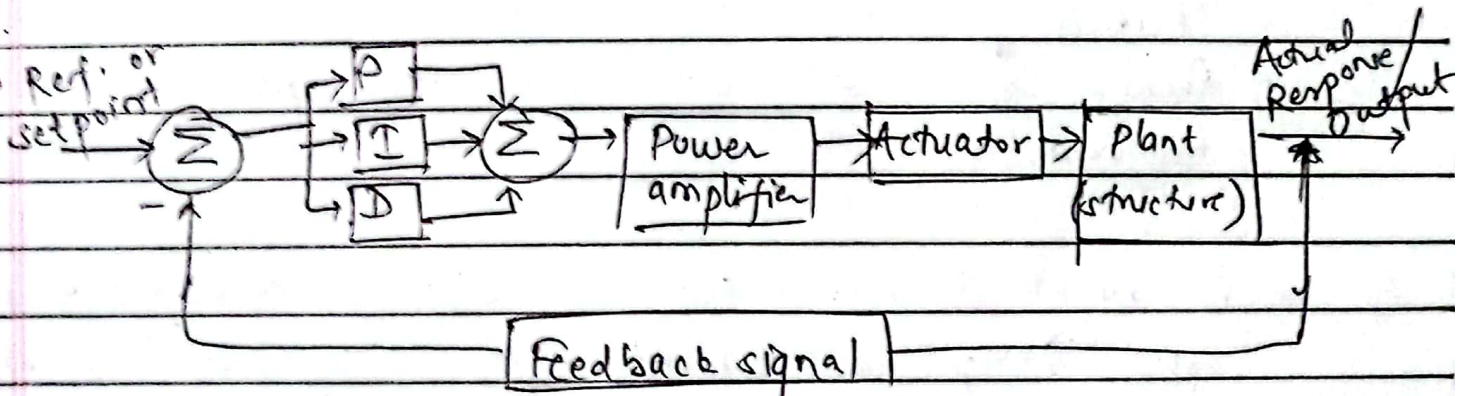

fig: PID Controller block diagram

PID tuning is the process of adjusting the parameters of a PID controller, a control loop feedback mechanism used in industrial CS, in order to optimize its performance in controlling a desired process variable.

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Three parameters of a PID controller are K_p, K_i, K_d where,

1. K_p determines controller's response to the current error bet^ the process variable & setpoint,
2. K_i determines controller's response to the accumulated error over time, ~~write the derivative~~ θ
3. K_d determines the controller's response to the rate of change of the error.

Algorithm:

1. Start with small P, $I = D = 0$
2. Increase D until seeing oscillation - Decrease delta a bit
3. Increase P until seeing oscillation - Decrease P a bit
4. Increase I until seeing oscillation
5. Repeat from 2nd step until the performance is improved.

Q. no. 8. What is a 7 segment display and write its types. Design a circuit with 7 segments display which is used as a counter watch which display second and minute.

→

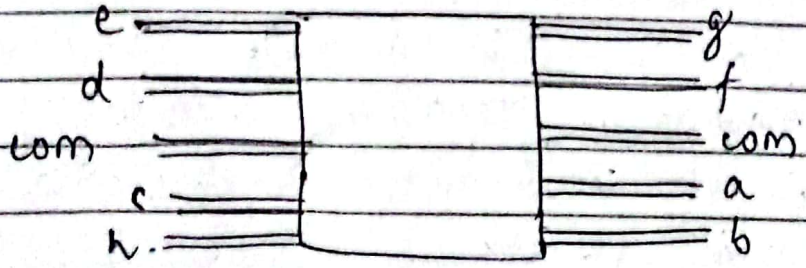

fig: 7-segment display

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Seven segment displays are important display units in Electronics and widely used to display numbers from 0 to 9. It can also display some character alphabets like A, B, C, H, F, E, etc.

Types:

1. Common cathode display: Cathode connections of LED segments are connected together to logic 0 or ground. We use logic 1 through a current limiting ~~resistor~~ resistor to forward bias the individual anode terminals a to g.
2. Common anode display: Anode connections of LED segments are connected together to logic 1. We use logic 0 through a current limiting resistor to the cathode of a particular segment a to g.

Program in 8051 microcontroller:

; set up resisters and variables

for a to g, dp → 0-6, 7

sbit segment_a = P2^0; define A as P2.0

:

sbit segment_dp = P2^7; define segment DP as P2.7

sbit digit_1 = P1^0; define digit 1 as P1.0

sbit digit_2 = P1^1; define digit 2 as P1.1

unsigned char seconds = 0; define seconds variable

unsigned char minutes = 0;

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```
; set up ISR
EX1:    push ACC;
        push PSW;
        inc seconds;
        jnc EX1_no_carry;
        inc minutes;
EX1_no_carry:
        mov A, seconds;
        anl A, #0F0H;
        mov seconds, A;
        mov A, minutes;
        anl A, #0F0H;
        mov minutes, A;
        pop PSW;
        pop ACC;
        reti;

; set up main loop
main:   mov TMOD, #01H;
        mov TICON, #01H;
        setb TR1;
        mov IE, #82H;

loop:   mov A, seconds;
        anl A, #0F0H;
        mov digit_1, A;
        mov A, minutes;
```

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anl A, #0F0H;
mov digit_2, A;
jmp loop;

Q. 9. Explain about PORT 3 of 8051 microcontroller. Using 8051 instructions, control rate of blink of LED at pin P1.1 by 2 switches at P2.1 and P2.2 (One to increase rate of blink, another to decrease rate of blick)

→ Port 3 is a multi-purpose I/O port in 8051 microcontroller. It is an 8-bit port, meaning it can handle 8-bit data at a time. PORT 3 has a total of 8 pins, labeled P3.0 to P3.7, which can be used as either I/O pins. Functions

1. External Interrupt
2. Serial communication
3. Timer Input
4. Address and data bus

→ To control the rate of blink of an LED at pin P1.1 using 2 switches at P2.1 and P2.2, you can use the following 8051 instructions.

1. Input pins: P2.1, P2.2 Output pin: P1.1

```
MOV P1,#0; 0
MOV P2,#0; I
```

2. Create loop:

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```
Loop:
    MOV  A, P2 ;
    ANL  A, #3;
    JZ   SKIP;
    JNC  INCR;
    DEC  R0;
    JMP  SKIP;
INCR:
    INC  R0;
SKIP:
    ____;
    JMP  LOOP ;
```

3. Use timer or delay loop to control actual blink rate.

```
BLINK:
    MOV  A, P1;
    CPL  A ;
    MOV  P1, A;
    MOV  R1, #0 ;
DELAY:
    DJNZ  R1, DELAY ;
    DJNZ  R0, BLINK;
```

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Q.7. Explain the matrices used to measure the control objectives. Explain software coding of PID controller.

→ Matrices:

1. Process Performance Index (PPI)

→ PPI measures the performance in terms of deviation of the process variable from its setpoint.

2. Integrated Squared error (ISE)

→ ISE measures integral of squared error bet^n process variable and setpoint over time.

3. Integral absolute error (IAE)

→ IAE measures integral of absolute error bet^n process variable and setpoint over time.

4. Integral of time-weighted absolute error (ITAE)

→ ITAE measures integral of time-weighted absolute error bet^n process variable and setpoint over time.

PID controller is a CS that uses a control loop to continuously adjust the output of a process to maintain process variable at a desired setpoint. The software coding of a PID controller involves implementing the control algorithm in a programming language. The algorithm takes as input the process, variable, setpoint, and (Kp, Ki, Kd), outputs the control signal to be applied to the process.

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PID in C:

```
#define Kp 1.0
#define Ki 0.1
#define Kd 0.5

float error, prev_error, integral, derivative, control;
void pid_control(float setpoint, float process_variable){
error = setpoint - process_variable;
integral += error;
derivative = error - prev_error;
control = Kp * error + Ki * integral + Kd * derivative;
prev_error = error;
}
```

Q. 8. Discuss advantages and disadvantages of full-custom IC technology. Explain the basic steps of photolithography process.

→ Full custom IC technology refers to the process of designing and manufacturing customized ICs for specific applications. This approach allows for greater control over design of IC.

Advantages:

1. High performance:
   By designing IC from scratch, it is possible to optimize the layout and circuits for max. performance.

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2. Greater design flexibility:
Full custom IC technology allows for incorporation of a wide range of circuits and components, enabling creation of customized ICs for specific applications.

3. Improved power efficiency:
Customized designes can be optimized for power consumption, reducing power requirements of IC.

4. Smaller size:
FCICs can be designed with a smaller size, allowing for the integration of more functions into a smaller space.

Disadvantages:
1. Higher cost: Complex, time-cosuming results in higher cost.
2. Longer development time: Design and manufactering takes time, so results in longer development time.
3. Limited production volume: Small and specific quantities.

→ steps of photolithography process:
1. Photomask preparation: (Reticle) : Photomask is created with a pattern that represents the desired layout of IC.
2. Photoresist coating: The wafer is coated with a light-sensitive photoresist material.
3. Photomask alignment: Photomask is aligned with the wafer using a precise alignment system.

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4. Exposure: The wafer is exposed to light through the photomask, ~~creat~~ causing the photoresist to become more soluble in a developer solution.

Q.3. Generate a periodic square wave having a period of 15 ms and a duty cycle of 20% in 8051 using assembly programming. The waveform should be produced at pin zero of port 2 (P2.0). The XTAL frequency is 11.0592 MHz and use timer 1 in mode 0 (13 bit timer mode).

Ans: Here is a code that generates a periodic square wave with a period of 15 ms and a duty cycle of 20% in 8051 using assembly programming

```
; Set timer 1 to run in mode 0 (13-bit timer mode)
MOV TMOD, #00
; set the XTAL frequency
MOV TH1, #0xFF
; set the baud rate to 9600
MOV SCON, #0x50
; Enable timer 1
SETB TR1

; Main Loop
MAIN_LOOP: ; Toggle P2.0
    MOV P2, #0x01
    ACALL DELAY
```

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```
MOV P2, #0x00
ACALL DELAY
JMP MAIN_LOOP

;DELAY function
DELAY: ; set timer 1 to run in 0: mode
MOV TMOD, #00
;Load initial value for the timer
MOV TH1, #0xFF
;set the baud rate to 9600
MOV SCON, #0x50
;Enable timer 1
SETB TR1

;Wait for 1 to overflow
DELAY_LOOP:
JNB TF1, DELAY_LOOP
CLR TR1
CLR TF1
RET
```

→ The period of the square wave is determined by the initial value of timer 1 and baud rate. In this case, the period is approx. 15 ms. The duty cycle of the square wave is determined by the length of time that P2.0 is highly relative to the total period of the waveform. In this case, the duty cycle is approx. 20%.

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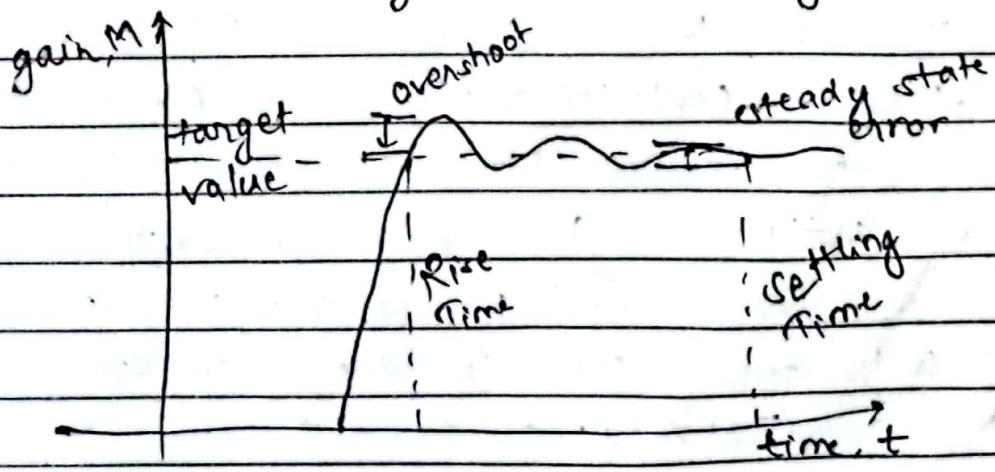
Q.7. Explain different performance metrics of CS using suitable performance response diagram. Write an algorithm for PID control.

→ Several metrics:

1. Settling time: This is the time it takes for the system output to reach and remain within a specified tolerance of final value.
2. Overshoot: It is the max. deviation of the system output from the final value.
3. Rise time: This is the time it takes for the system output to rise from a specified lower bound to a specified upper bound.
4. Steady state error: This is the difference betⁿ the final value of the system output and reference value.
5. Frequency response: This is a measure of how the system responds to sinusoidal inputs at different frequencies.
6. Bandwidth: This is the range of frequencies over which system can accurately reproduce a given input signal.



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→ PID control is a widely used control algorithm that is used to maintain a process or system at a desired output.

Algorithm:

```
def pid_control (measured_value, setpoint, Kp, Ki, Kd):
    prev_error = 0
    integral = 0
    error = setpoint - measured_value
    integral = integral + error
    derivative = error - prev_error
    control_action = Kp * error + Ki * integral + Kd *
                     derivative
    prev_error = error
    return control_action
```

Q. 8. Describe briefly about semi custom IC technology. Explain the various steps involved in photolithography.

→

Semi custom IC technology is a type of IC design and fabrication process in which a standard IC manufacturing process is modified to meet the specific requirements of a particular application. These aka ASICs, which are typically customized for a particular application or system, and they offer a higher level of performance, power efficiency and cost effectiveness compared to other IC technologies such as standard-cell or full custom ICs.

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Semi-custom ICs are designed and fabricated using a process similar to standard-cell IC, but with additional customization steps to meet specific requirements of the application.

Steps involved in photolithography:

1. Substrate prep^n: Substrate is base material onto which pattern will be transferred.
2. Mask prep^n: Mask is a template that defines the pattern that will be transferred onto substrate.
3. Exposure: Substrate is placed on a stage, and the mask is positioned above it.
4. Developing: Substrate is then placed in a developer sol^n, which removes photoresist in the unexposed areas, leaving a pattern of photo resist on substrate
5. Etching: Substrate is then placed in etching sol^n, which removes underlying material in areas where the photoresist has been removed.
6. Removing photoresist: Rest of photoresist is removed from substrate using solvent.
7. Deposition: Next layer of material is then deposited onto substrate, using sputtering or chemical vapor deposition.

Q.9. Explain different configuration for seven segment display. Write a assembly program to design a down counter that counts from 99 to 00.

→ Seven segment display ✓

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Common configurations:

1. Common cathode: Here, all the cathodes (-ve terminals) of the segments are connected together and are connected to ground. The anodes of the segments are connected to individual drivers which can turn on or off each segment individually.

2. Common anode: Here, all nodes of segments are connected together and are connected to positive voltage supply. Cathodes of segments are connected to individual driver which can turn or or off each segment individually.

3. Bi-color: Here, each segment is made up of 2 differently coloured LEDs (eg red & green). They are in parallelly connected with the anodes connected to individual drivers in common driver circuit.

4. Multiplexed: Here, segments of multiple displays are multiplexed together and are turned on or off in rapid sequence to reduce the no. of drivers required. This can be done in either common anode or cathode configurations. It helps to reduce cost & complexity of the display.

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Program:

```
; set up the registers
mov ah, 0;
mov al, 99;
mov bl, 10;
mov bh, 0;
; set up the loop
down_counter:
    ; Extract tens digit
    div bl;
    mov cl, ah;
    mov ah, 0;
    ; Extract ones digit
    mov dl, al;
    ; Print counter value
    add dl, '0';
    mov ah, 02h;
    int 21h;
    mov ah, 00h;
    mov al, cl;
    add al, '0';
    int 21h;
    ; Decrement counter
    dec al
    jnz down_counter;
; end of program
mov ah, 4ch; interrupt
int 21h;
```

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2078 Poush

Q.7. Compare and contrast bet^n closed-loop and open-loop CS. Explain PID control system with its typical block diagram.

→ Difference bet^n ✓✓

→ PID control system is a type of CS that uses feedback to adjust output of a system or process to achieve a desired result.

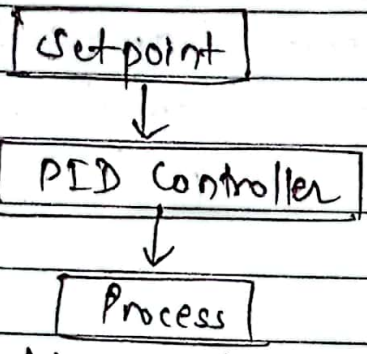

fig: block diagram

PID controller adjusts the output based on 3 components:

1. Kp, based on current error signal
2. Ki, based on accumulated error over time.
3. Kd, based on rate of change of the error signal.

PID control system is a widely used and effective CS that uses feedback to adjust the o/p of a system or process to achieve a desired result.

Q.8. Describe steps involved in the design of Full-custom, semi-custom and PLD.

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Full custom design:

→ 1. Define requirements and specifications for the IC.
2. Create a high-level design for the IC.
3. Develop a detailed design for the IC.
4. Verify the design using simulation and other verification techniques.
5. Fabricate the IC using photolithography and other manufacturing process.
6. Test and ~~evaluate~~ validate fabricated IC to ensure that it meets specified requirements.

Semi-custom design:

→ 1. Define requirements and specifications for the IC.
2. Select a semi-custom design platform (cell library) that meets the requirements of IC.
3. Create a high-level design.
4. Develop a detailed design.
5. Verify design using simulation and other verification techniques.
6. Fabricate the IC using photolithography and other manufacturing processes.
7. Test and validate the fabricated IC to ensure that it meets the specified requirements.

PLD design:

→ 1. Define requirements and specifications for the IC.
2. Select a PLD device that meets the requirements

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of IC. PLD devices are programmable ICs that can be configured to perform a specific function.

3. Use a design tool to create a high-level design for IC. This involves defining the overall architecture and top-level block diagram of IC.
4. Use design tool to create a detailed design for IC. This involves specifying the function of each component and interconnect of IC.
5. Verify the design
6. Program the PLD device
7. Test & validate programmed PLD device.

Q. (9) Explain the data memory organization in 8051 microcontroller. Write an assembly program for 8051 to count no. of 0's in an 8,- bit data stored in ROM at 75H & store Result in RAM at 45H.

→ Data memory orgonization:

1. Internal RAM: 8051 has 128 bytes of internal RAM, which is used to store data and intermediate results during execution of programs.

2. External RAM: 8051 can access external RAM through its memory mapped I/O ports. This allows the microcontroller to access aditional memory if needed.

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3. Special Function Registers (SFRs): 8051 has a no. of SFRs that are used to control microcontroller's various functions. These registers are located in a specific address range within the internal RAM and can be accessed using specific instructions.

Program:

```
; Set up stack pointer and data pointers
MOV SP, #7FH ;
MOV DPL, #45H;
MOV DPH, #0 ;

; Initiate the counter
MOV A,#0 ;
; Load data from ROM
MOVC A, @A+DPTR ;
; Count the no of 0's in data
CLR C ;
MOV R3,#8 ;

Loop:
   RRC A;
   JNC skip;
   INC DPL;
   skip:
    DJNZ R3 loop

; save result to RAM
```

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```
MOV @DPTR, A

;Halt the program
HLT
```

2079 Jestha

7. How is closed loop system better than open loop controller? Explain with example of cruise control system. Why is an Integral controller needed in a control system

7. Design an open loop automatic cruise controller and derive conditions for no oscillation & reduction of road disturbance and determine performance parameters.

→

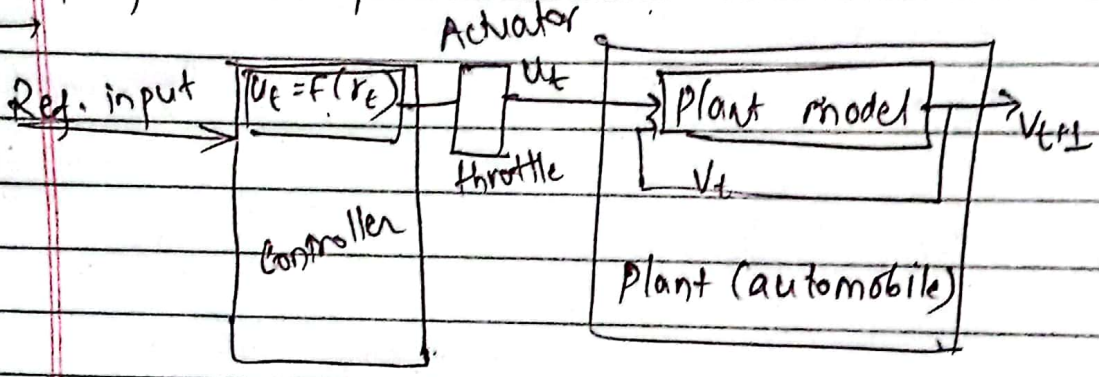

fig: open loop cruise CS

An open loop cruise CS is a system that automatically adjusts the speed of a vehicle to maintain a safe distance from vehicle ahead. There are several design considerations that need to be taken into account in order to achieve good performance.

First, it is important to ensure that system has good stability, so that it doesn't oscillate or overreact to changes in the road or vehicle ahead. This can be achieved by properly designing control algorithm and carefully selecting the control parameter. To design control algorithm, we use PID controller.

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The important design consideration is the ability to reduce road disturbance and minimize the impact of bumps or rough surfaces on the vehicle's speed. The performance parameters are:

1. Tracking error: It is difference betn the desired speed and actual speed of vehicle.

2. Overshoot: It is the amount by which the vehicle's speed exceeds desired speed when the system is responding to a change in the road or vehicle ahead.

3. Settling time: It is the time taken for system to stabilize after a change in the road or vehicle ahead.

4. Noise rejection: It is the ability of the system to filter out high-frequency noise and maintain stable performance in the presence of measurement noise or other disturbances.

Model of plant: Example:

Let $V_t = 50$ mph, open throttle to 40 degree

$V_{t+1} = 55$ mph,

Then, $V_{t+1} = 0.7 * V_t + 0.5 * U_t$

$55 = 0.7 * 50 + 0.5 * 40$ → Model of a plant

Designing the controller: Simple linear func^n,

$U_t = f(r_t) = P * r_t$, r_t → desired speed

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Here, $V_{t+1} = 0.7 * V_t + 0.5 * U_t$

$= 0.7 * V_t + 0.5 \rho * r_t$

At steady state, V_{ss}, $V_{t+1} = V_t = V_{ss}$

$\therefore V_{ss} = 0.7 * V_{ss} + 0.5 \rho r_t$

Also, at steady state $r_t = V_{ss}$

$\therefore \rho = 0.6$

i.e. $U_t = 0.6 * r_t$

Analyzing the controller:

Let $V_0 = 20$ mph, $r_0 = 50$ mph

$V_{t+1} = 0.7 * V_t + 0.5 (0.6) * r_t$

$= 0.7 * V_t + 15$

Throttle position is $0.6 * 50 = 30$ degree.

Considering the disturbance

Assume road grade can affect speed from -5 mph to $+5$ mph

$\rightarrow V_{t+1} = 0.7 * V_t + 10$

$\rightarrow V_{t+1} = 0.7 * V_t + 20$

are 2 equations.

Determing performance,

$V_{t+1} = 0.7 * V_t + 0.5 \rho * r_0 - w_0$

$\therefore V_1 = 0.7 * V_0 + 0.5 \rho * r_0 - w_0$

$\therefore V_2 = 0.7 * V_1 + 0.5 \rho * r_0 - w_0$

$= 0.7 * 0.7 * V_0 + (0.7 + 1) * 0.5 \rho r_0 - (0.7 + 1.0) w_0$

$\therefore V_t = 0.7^t V_0 + (0.7^{t-1} + 0.7^{t-2} + \ldots + 0.7 + 1) \cdot (0.5 \rho r_0 - w_0)$

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Q.8. Explain importance of photolithography in IC manufacturing.

→ Photolithography is a process used in manufacturing of ICs to pattern thin films of material onto a substrate. It is an essential step in IC manufacturing process, as it allows for precise placement of the various components that make up an IC.

Importance :

1. High resolution : It allows for patterning of features with a high degree of resolution, enabling the creation of very small and densely packed ICs.

2. High accuracy : It allows for precise placement of various components within an IC,

3. Mass production : It is a scalable process, allowing for mass production of ICs.

4. Versatility : It can be used to pattern a wide range of materials, including metals, semi-conductors and insulators.

Q.9. Describe the different purpose of port 3 and port 2 of 8051 microcontroller?. Write a programming for 8051 microcontroller to read the data from switches connected at port 1 and send it to port 2 for display in LED.

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→ 8051 microcontroller has 4 I/O ports, labeled P0, P1, P2, P3. These ports can be used to communicate with external devices and perform a variety of funcns.

- Port 3 (P3): It is a bidirectional port that can be used for both input and output. It has 8 pins, which can be used to communicate with external devices, sensors, displays, etc. It also has interrupt lines and an external memory interface.
- Port 2 (P2): It is a bidirectional port that can be used for both I/O. It has 8 pins, which can be used to communicate with external devices like sensors, displays, etc. It can be used to access external memory.

→ Program:

```
; Program to read data from switches at P1 and
display it on LEDs at P2
org 0h;
start;
mov A, P1;
mov P2, A;
sjmp start;
end;
```

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