**Cairo University**
**Faculty of Engineering**
**Systems and Biomedical Engineering**
**Credit Hours System**

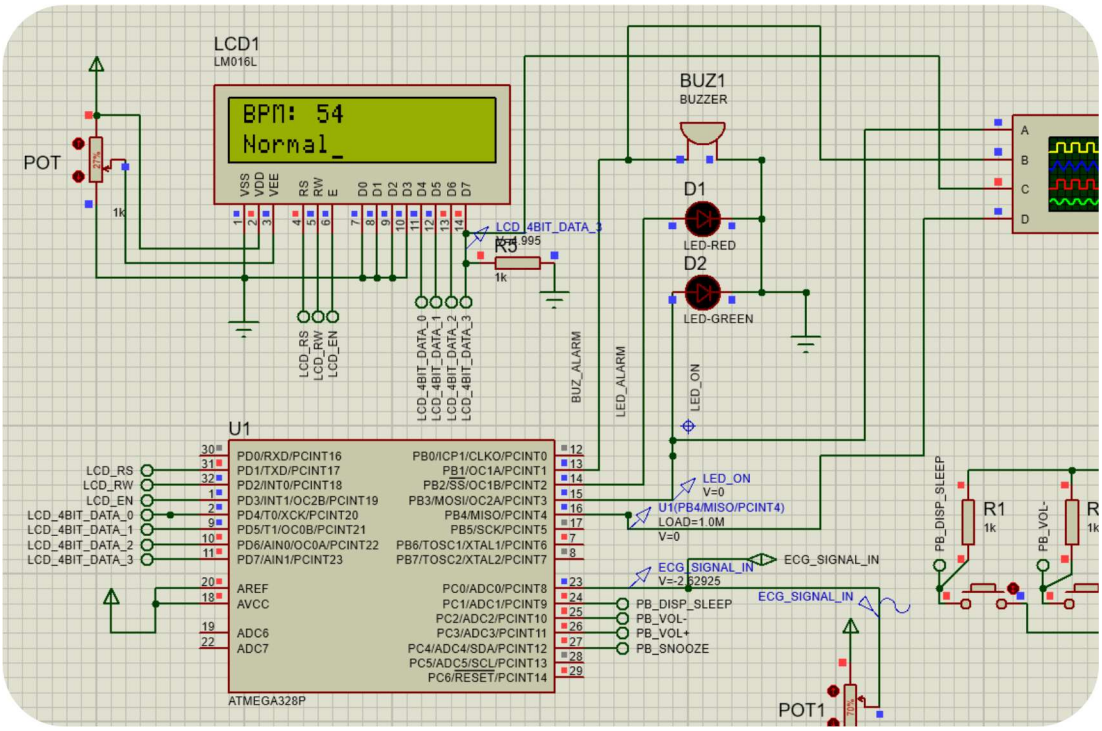
# ICU Heartrate Monitor

## SBEN430: Final Project

### Advanced Topics in Embedded Systems

**Prepared By:** Mohamed Nasser 1190438

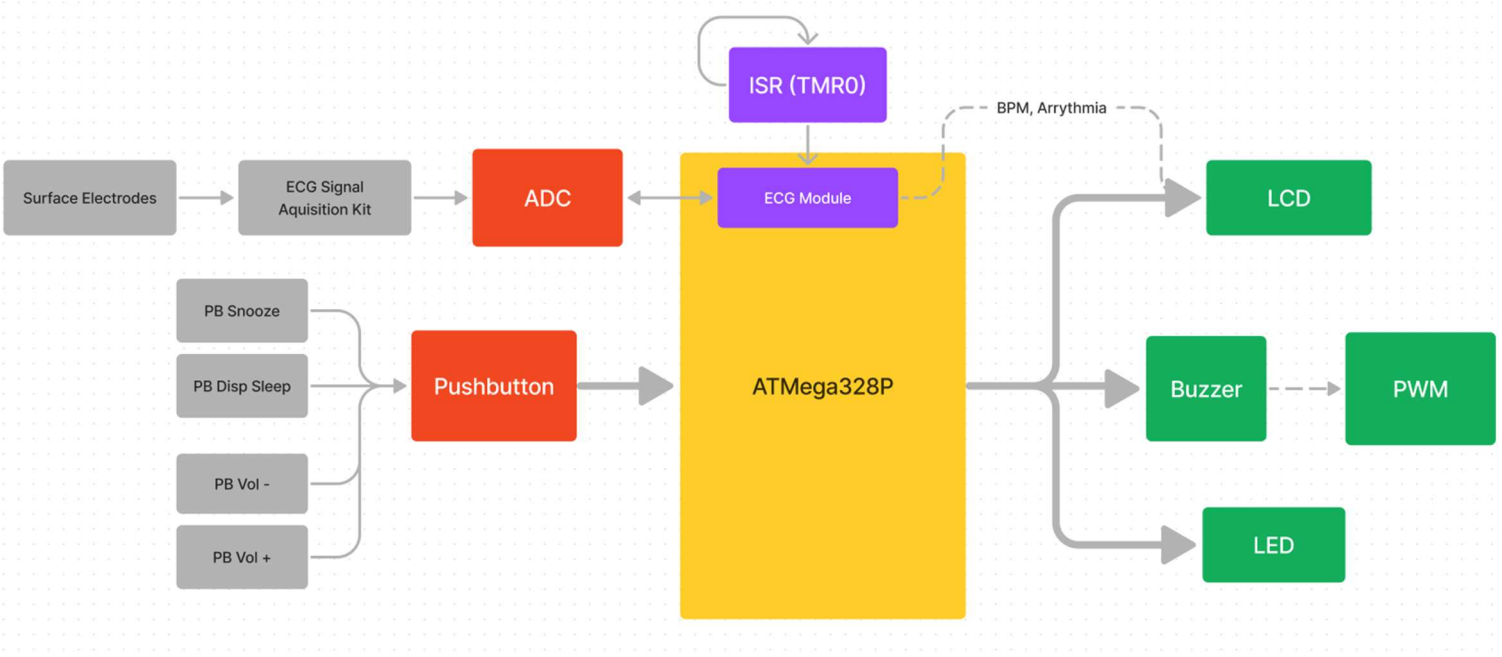
**Submitted to:** Eng. Amr Abdelnaby, Eng. Mohamed Mostafa



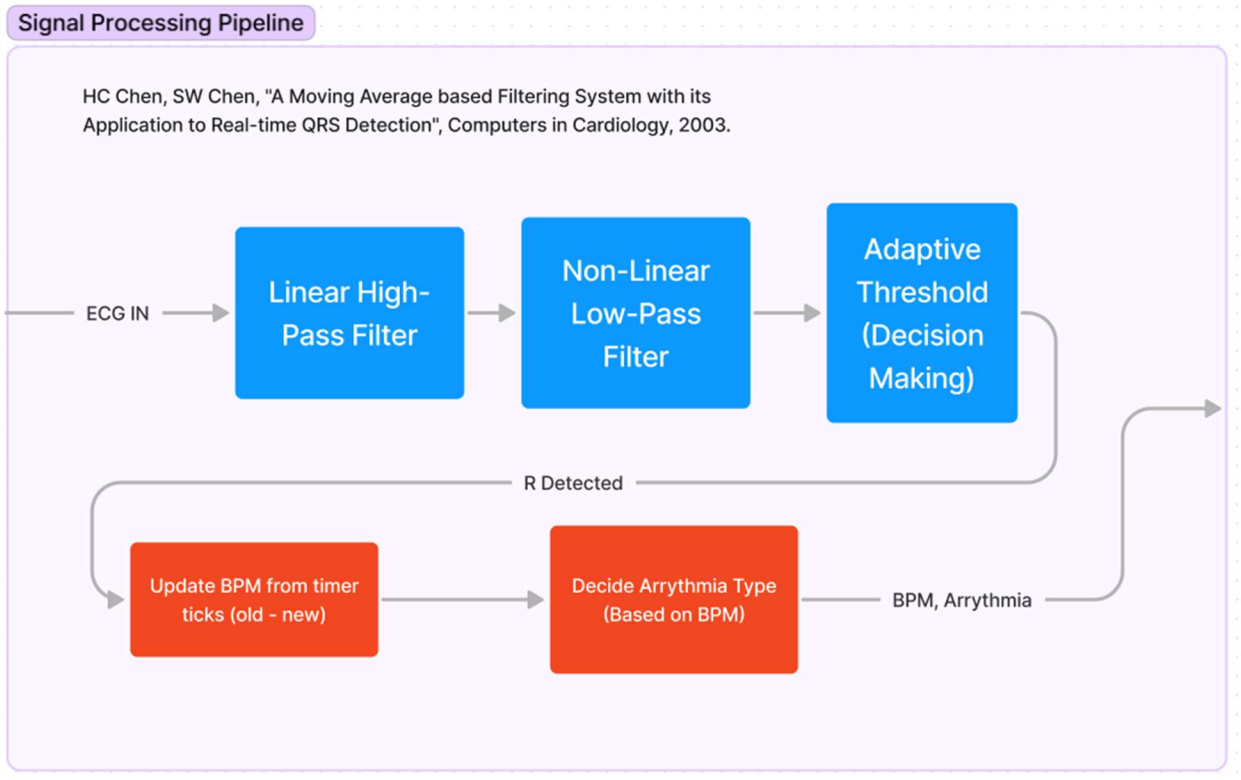
# Contents

# System Design

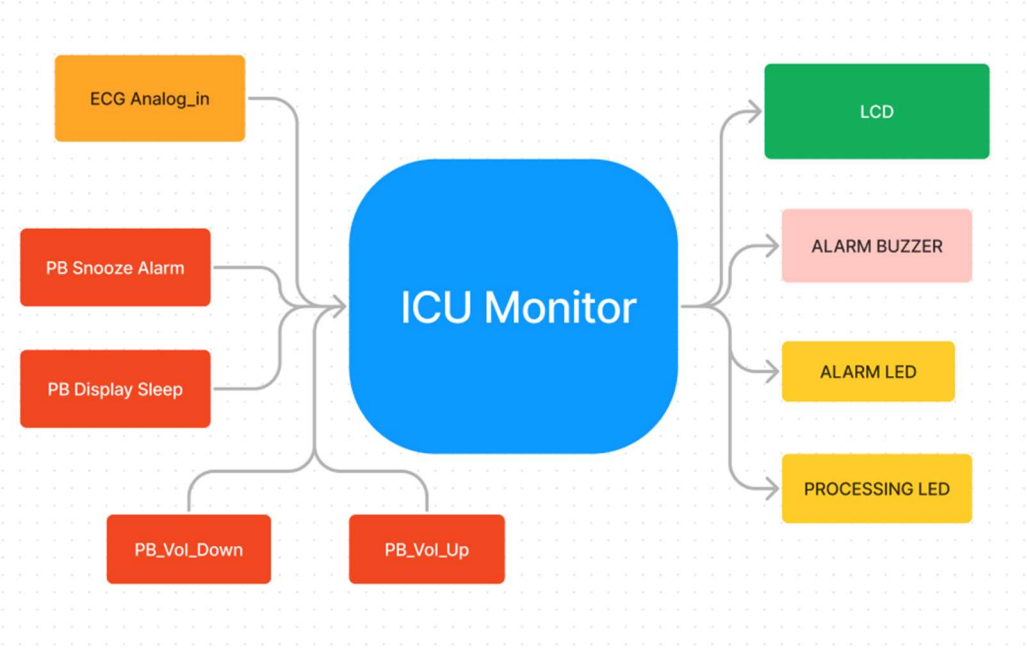
## Block Diagram



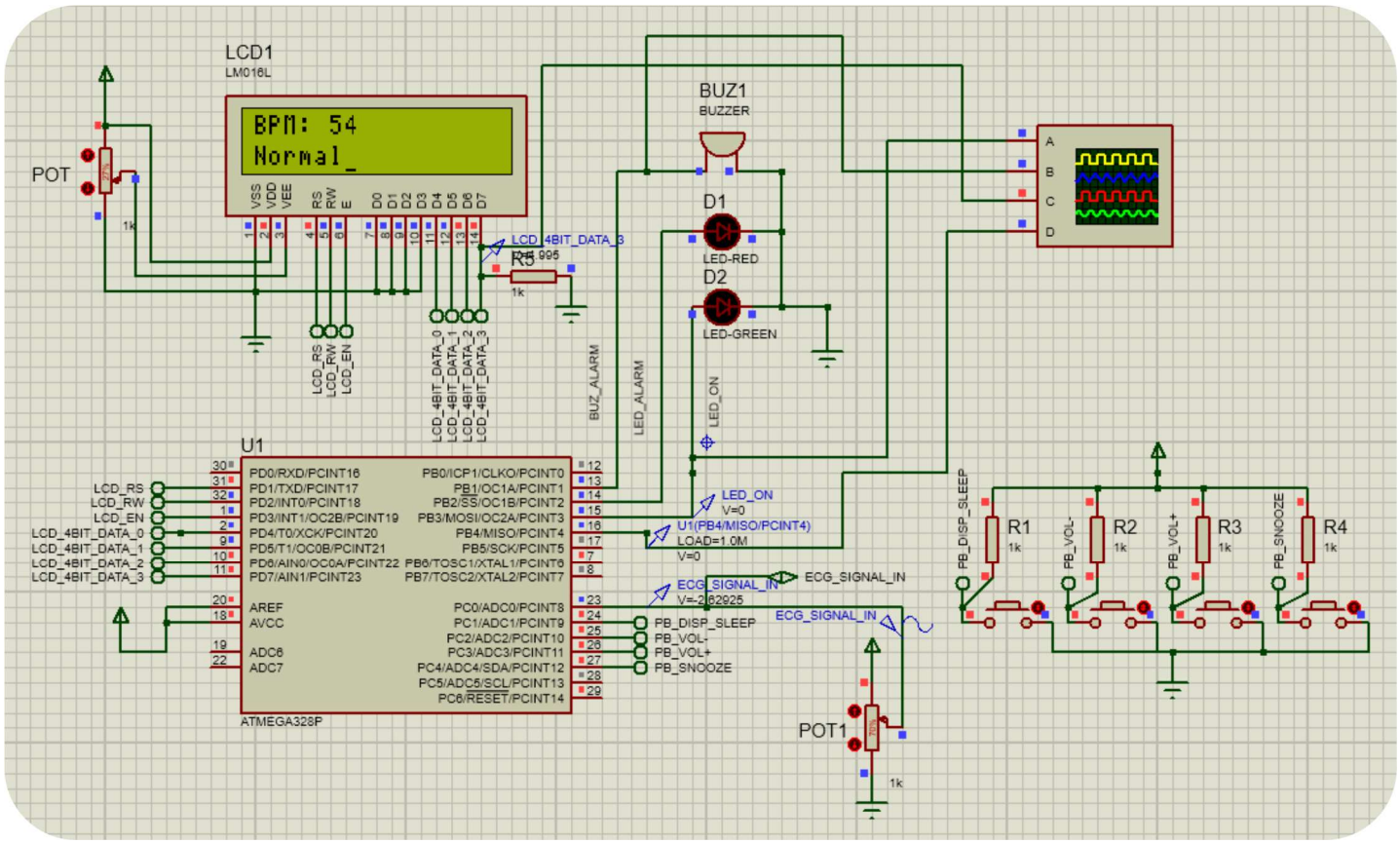

### ECG Module Detailed Design



## Context Diagram




## Circuit Diagram

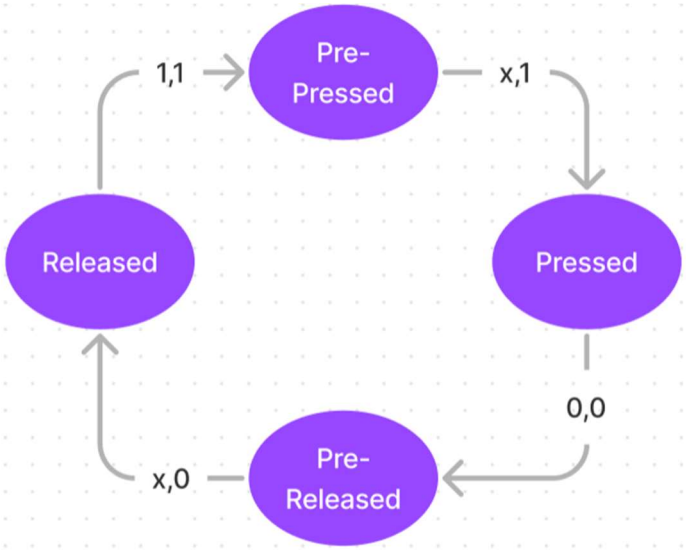


# Unit Testing Report

## Pushbutton Module

### PB_Update ()

***State Diagram***




***State Transition Table***

| | | Events (Pin Samples) | | | |
|---|---|---|---|---|---|
| | | x,1 | 0,0 | x,0 | 1,1 |
| **States** | S1: Pre- Pressed | S2 | -- | -- | -- |
| | S2: Pressed | -- | S3 | -- | -- |
| | S3: Pre- Released | -- | -- | S4 | -- |
| | S4: Released | -- | -- | -- | S1 |

***0 - Switch Coverage***

This also achieves full round trip coverage

| 0-Switch |
|---|
| S1 (1, 1) |
| S2 (x,0) |
| S3 (0,0) |
| S4 (x,1) |

***Invalid Transition Test***

S1 (1,1) S2(0,0) S3 **(1,0)** S4(1,1)

### PB_Init (tPB pb, tPB_State), PB_GetState(tPB pb), PB_SetState(tPB pb, tPB_State)

*Equivalence Partitioning*

| Test Case | tPB | tPB_State |
|---|---|---|
| 1 | PB_VOL_PLUS | PB_RELEASED |
| 2 | PB_VOL_MINUS | PB_PRE_PRESSED |
| 3 | PB_SNOOZE | PB_PRESSED |
| 4 | PB_DISP_SLEEP | PB_PRE_PRESSED |
| 5 | PB_DISP_SLEEP | 4 |
| 6 | 4 | PB_RELEASED |
| 7 | PB_SNOOZE | -1 |
| 8 | -1 | PB_PRE_PRESSED |

### PB_GetClicks (tPB pb), PB_ResetClicks (tPB pb)

*Equivalence Partitioning*

| Test Case | tPB pb |
|---|---|
| 1 | PB_VOL_PLUS |
| 2 | PB_VOL_MINUS |
| 3 | PB_SNOOZE |
| 4 | PB_DISP_SLEEP |
| 5 | 4 |
| 6 | -1 |

## LED Module

### LED_Init(tLED, tLED_State), LED_SetState(tLED, tLED_State), LED_GetState(tLED, tLED_State), LED_On(tLED, tLED_State), LED_Off(tLED, tLED_State), LED_Toggle(tLED, tLED_State)

*Equivalence Partitioning*

| Test Case | tLED | tLED_State |
|---|---|---|
| 1 | LED_ALARM | LED_ON |
| 2 | LED_PROCESSING | LED_OFF |
| 3 | LED_ALARM | 2 |
| 4 | 2 | LED_ON |
| 5 | LED_PROCESSING | -1 |
| 6 | -1 | LED_OFF |

# Timing Analysis Table

## Low Priority (While Loop)

| Task | BCET | WCET |
|---|---|---|
| **LCD_UpdateDisplay** | 1.40 ms | 10.15 ms |

## ISR Loop

| ISR Task | BCET | WCET | Period of Task | Tick no. (tick = 1ms) |
|---|---|---|---|---|
| **ECG_Update** | 145.17 us | 308.2 us | 4ms | 1st |
| **PB_Update** | 11.5 us | 11.78 us | 4ms | 2nd |
| **BUZ_Update** | 1.46 us | 2.11 us | 4ms | 2nd |
| **ECG_Update_Alarm** | 3.91 us | 4.03 us | 4ms | 3rd |