

## CE 2: Digital B.M.I. Instrument

### Introduction

**CE 2.1** I have covered a project in this career episode which I undertook during my degree in Biomedical Engineering Undergraduate Program at [REDACTED]. The title of this project was Digital B.M.I. Instrument. This project aimed to serve the medical industry by developing an instrument for determining body mass index of individuals. This project was completed in period of 16 weeks [REDACTED]. I worked with my four classmates under the guidance of our supervisor, [REDACTED]. The project was an important component of my degree. I addressed the need for accurate assessment of body by creating a more reliable instrument as compared to traditional methods. I applied my engineering skills, gained practical experience and enhanced my understanding of Body Mass Index calculation and its importance.

### Background

**CE 2.2** While doing my degree in Biomedical Engineering at [REDACTED] Karachi, I undertook the Digital B.M.I. Instrument project. Aim of this project was to develop an instrument for determining the body mass index (BMI) of individuals. The primary objective of this project was to create an instrument which is capable of accurately assessing a person's body composition. Traditional methods of relying on weight only often proved inadequate in providing an accurate status of person's health. Considering this, in my project I aimed to address this limitation by developing a BMI measurement instrument capable of offering a more detailed evaluation of an individual's body composition.

**CE 2.3** I designed and developed Digital B.M.I. Instrument. I was the team leader and organized the project. My responsibilities were to mentor the teammates, ensure progress and to maintain communication with teammates and supervisor.



Figure 1: Hierarchy

Figure 1 shows the organizational structure of the project with the number of team members involved. I formed a team with my four classmates to implement the project. We all worked under the guidance and support of our project supervisor [REDACTED].

**CE 2.4** I oversaw the progress of project and made sure that each team member completes their responsibilities. I also implemented strategies for maintaining motivation of my team.

**CE 2.5** I applied my theoretical knowledge and technical expertise learned in biomedical engineering in this project. I carried out detailed study of BMI, explored its usage, identified the health risks, calculated the

formulas, defined categories and examined its practical applications. Utilizing this understanding I designed a more accurate and reliable instrument.

- CE 2.6** I also selected hardware components and designed decisions. I carried out research for identifying the components used in digital B.M.I instrument. I chose microprocessor, P.I.C. 16F877a, LCD display, PCB, voltage regulator IC, power supply adaptor, pushbuttons, resistors, connectors, potentiometer, load cell, Op07 op-amp and HC-SR04 ultrasonic sensor for my project on the basis of their specifications and requirements.
- CE 2.7** In hardware design I used different circuits for measurement of height, weight and communication. I used ultrasonic sensor in height measurement circuit for calculating distance. I used load cell with strain gauges in weight measurement circuit and an Op-amp for amplification of the electrical signal. I used Max 232 and a DB-9 connector to interface with a computer in communication circuit.

### **Personal Engineering Activity**

- CE 2.8** During this project as a team leader, I applied my engineering knowledge and skills for ensuring the successful implementation of instrument. I coordinated with my teammates and supervisor guaranteeing mutual understanding of their roles and responsibilities. I also arranged frequent meetings with my team to address issues and offer guidance to support each other.
- CE 2.9** I started this project with a detailed literature review on B.M.I, its calculation methods and health implications. I gained a thorough understanding of the subject matter and ensured that the designed instrument was capable of accurately measuring and assessing B.M.I. I explored the use of B.M.I. and explained it to my teammates for their understanding of the significance of the B.M.I. instrument and remain motivated towards their assigned tasks. During the research I found that B.M.I. was a popular weight-and-height-based metric which is used to quantify body fat and predict risks associated with health. I understood that B.M.I. assisted health providers in objectively discussing weight and assessing the risk of chronic illnesses, guiding preventive care and treatment options for overall health.
- CE 2.10** I also studied about the risks associated with different levels of B.M.I. I studied the risks of overweight and physically inactive individuals and those who were underweight and malnourished. I learned that distribution of body fat in certain areas of the body indicated different risks associated to health. I conducted search for the formula which is required for calculating the BMI of any individual manually. I collected information on the ranges that classified individuals as normal, overweight, obese I, II and III in the B.M.I. table. I also learned about the key parameters involved in B.M.I. calculation which are height and weight measurements. I explored many applications of B.M.I. for highlighting its importance in the medical industry and for well-being of individuals. I observed that the B.M.I.s importance was growing as people became fitness conscious. This knowledge provided me guidance in designing my digital B.M.I. instrument with greater accuracy.
- CE 2.11** On the basis of my research I led the team in the selection of hardware components. I analyzed the specifications and requirements of every component and made decisions in order to ensure its compatibility and functionality. I searched for a microcontroller which was suitable for my project. I then chose P.I.C. 16F877a microcontroller which is a compact integrated circuit having 8-bit capabilities and frequency of 20 MHz. This microcontroller came in a package of D.I.P. having 40 pins, 31 of which were assigned only for I/O operations. It also included a P.W.M. module and a communication module for making it ideal for my project.
- CE 2.12** I chose 20x4 LCD for accommodating 20 characters across 4 lines. This LCD display had 16 pins with 8 pins for transmission of data and remaining for other functions. For supporting and connecting the electronic components I used a P.C.B which is a non-conductive substrate with copper traces for providing the mechanical support and electrical connectivity for my project.
- CE 2.13** I chose 7805 voltage regulator IC having capability of stabilizing voltage within the range of 4.8 -5.2 volts. It had three pins; input, output and ground. It facilitated the effective voltage regulation. I chose an adaptor with a rating of 12 volts and 1.5 amperes for powering the circuit. I also used three push buttons, resistors, connectors and a potentiometer into the design for enhancing the functionality and interaction of user.
- CE 2.14** I also selected two main components for weight circuit. The first component was a load cell with four strain gauges arranged in a Wheatstone bridge configuration. I converted the applied load into a change in electrical resistance generating a small electrical signal using this load cell. The second component was

an Op-amp, Op07 model. It has high gain and single-ended output for amplifying the tiny signals from the load cell. I operated it on 5-volts power supply and boasted characteristics of low D.C. offset, minimal drift, low noise levels and high gain. Moving to height circuit, I only required one component, which was an ultrasonic sensor. I selected the HC-SR04 model as it was capable of measuring distances from 2cm - 400cm. It consisted of ultrasonic transmitters, a receiver and a control circuit with all operating on a power supply of 5-volts.

**CE 2.15** For establishing communication circuit, I chose Max 232 which enabled voltage level conversion between the microcontroller and the P.C.B. I used it for computer interfacing. I also used a DB-9 female connector for providing a connection point for Max 232. The DB-9 connector had nine holes and a female connection interface.

**CE 2.16** One of the major issues I encountered was designing of a measure height circuit using an ultrasonic sensor. I faced challenge in calibrating the sensor for providing precise measurements of distance. I worked to solve this issue by researching the specifications of sensor and experimenting with different configurations. By trial and error, I successfully implemented a circuit which accurately measured height and provided correct data for B.M.I calculation. I successfully assembled a circuit for measuring height. I used HC-SR04 ultrasonic sensor in the circuit which emitted and received ultrasonic waves. To initiate the process of measurement I sent a high pulse to the trigger input of the sensor which caused it to emit ultrasonic waves. On receiving the echo, the echo pin generated a pulse until the echo signal concluded. I calculated the timing of the echo pulse and determined the distance using the microprocessor accurately.

**CE 2.17** I then constructed a circuit for weight measurement. I chose a load cell having capacity range of 2 -150 kg. This load cell included four strain gauges which were interconnected in a Wheatstone bridge configuration. When I subjected it to a load it experienced deformation which resulted in the production of a few millivolts of electrical signal output. I amplified this signal using OP07 instrumentation amplifier and transmitted it to the microcontroller for measurement of weight. I connected the P.C.P.C. and the microcontroller to the HyperTerminal to establish communication between the microcontroller and the computer interface. I utilized a Max 232 which is a specialized integrated circuit responsible for voltage level conversion for aiding this connection. I also used a DB-9 connection for interfacing the Max 232 and the computer.

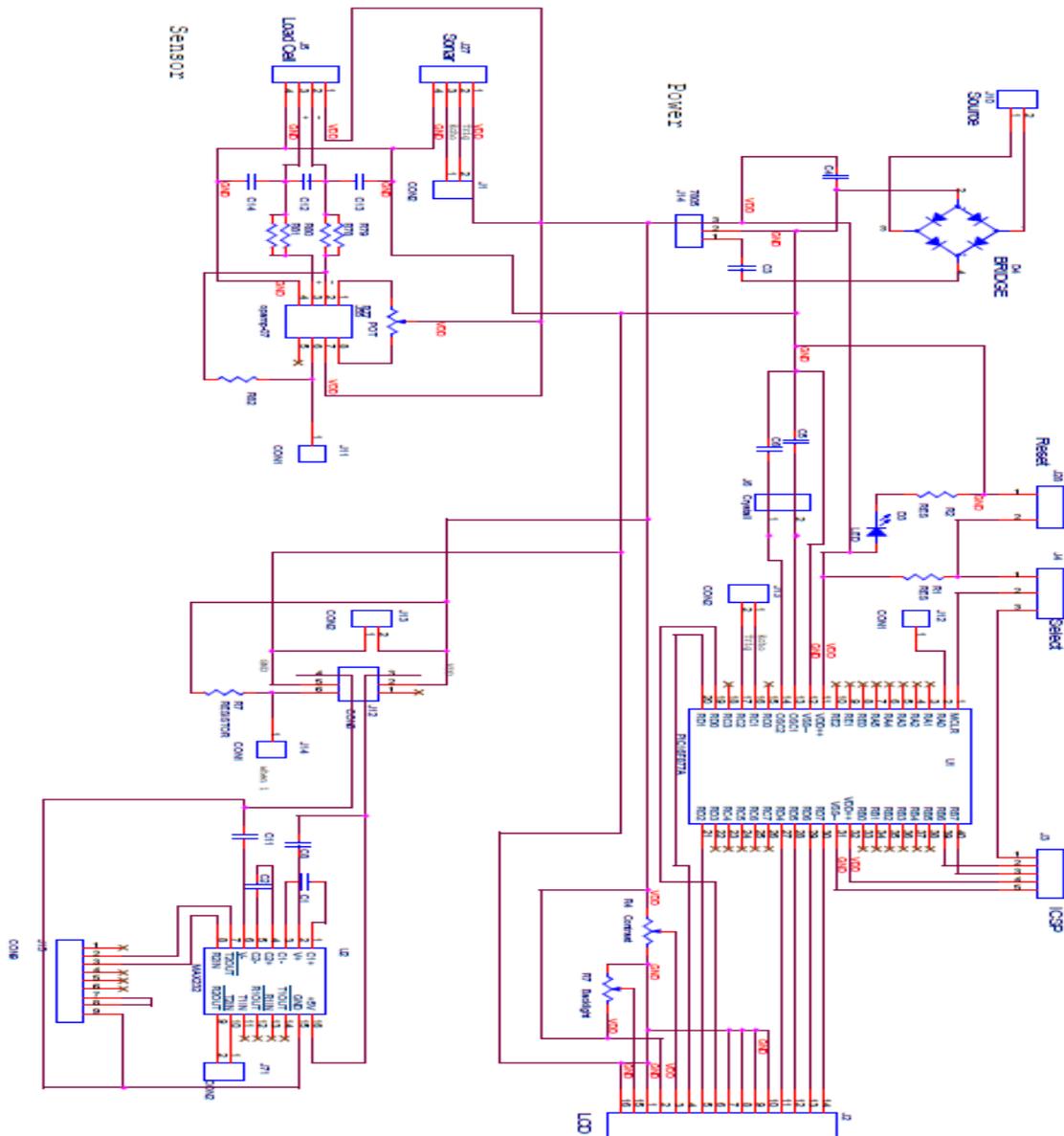


Figure 2: Circuit Diagram for B.M.I.

- CE 2.18** I programmed the microprocessor P.I.C. 16F877a for controlling the operations of instrument. I used my programming skills in C language for developing the algorithms for calculation of B.M.I, processing of data and LCD display. I considered user-friendly features including button inputs for navigating through the instrument's menu and options in my system.
- CE 2.19** I coordinated with other team members to ensure smooth progress. I created a cooperative and supportive environment for encouraging open communication and knowledge sharing between the team members. I organized meetings for collectively addressing the technical challenges and explore innovative solutions. I assigned duties to my team members based on their expertise and interests. I recognized the importance of using each individual's strengths for maximizing the collective productivity. I divided tasks of PCB designing, component soldering and circuit testing to make sure that everyone had a meaningful contribution to the project.
- CE 2.20** I also documented the project report. I compiled detailed technical report covering the project's objectives, methodologies, design considerations and implementation details. I also documented all the hardware and software specifications, circuit diagrams and programming codes for my work to be replicated or developed further in the future.

## Summary

- CE 2.21** Working on this project of Digital B.M.I. Instrument was an enriching experience for me. In this section I have provided a summary of my impressions of the engineering activity and the role I played in this project.
- CE 2.22** This Digital B.M.I. Instrument project proved significant in the field of medical. My aim was to create a precise and effective tool for measuring and calculating B.M.I which is a key factor in assessing overall health and well-being of any individual. I successfully met the objectives of project and this instrument I developed proved to be reliable and effective in its functionality.
- CE 2.23** I provided guidance to my team by ensuring effective communication and coordination among teammates. I made informed decisions using my engineering principles knowledge in hardware and software selection process. I conducted extensive research and employed problem-solving technique. I addressed the technical difficulties I faced in designing a circuit for accurate height measurement using an ultrasonic sensor.
- CE 2.24** I assigned tasks to my teammates based on their strengths and knowledge. I ensured that expertise of every team member was utilized to the fullest potential.
- CE 2.25** I achieved my goals and requirement which resulted in the development of an instrument that accurately measures and calculates B.M.I. This experience of working on this project enhanced my engineering competencies allowing me to apply my theoretical knowledge to practical applications.