CE 3: Refrigerated Centrifuge

Introduction

CE 3.1 This career episode includes my semester project where I transformed an ordinary clinical centrifuge into a refrigerated centrifuge. Aim of this project was to offer technological advancement for medical laboratory instrumentation, testing, analysis and sample diagnosis more convenient and accurate for doctors. I started working on this project on [redacted] ta period of almost 16 weeks. I worked with three other classmates and received guidance from [redacted] as my supervisors. I worked on this project at [redacted], Pakistan.

Background

CE 3.2 I worked on this project as part of my degree in Biomedical Engineering from SSUET. I learned about technological advancements in medical laboratory instrumentation. My aim was to enhance the functionality and capabilities of instruments already present for improving testing, analysis and diagnosis in medical laboratories. The main objective of my project was to transform an ordinary clinical centrifuge into a refrigerated centrifuge. I recognized the significance of temperature control in preserving sample sensitivity and integrity during analysis. I introduced refrigeration capabilities, aiming at enabling doctors and laboratory technicians to perform their tasks more conveniently and accurately.

CE 3.3 Due to my understanding of the significance of technological advancements in the field of biomedical engineering I was motivated to work on this project. I improved the medical laboratory instruments by integrating various disciplines for achieving common goals. I explored and advanced the capabilities of the clinical centrifuge by enhancing its functionality and introducing the concept of refrigeration to preserve sample integrity and stability.

CE 3.4 I did research, worked on development and implementation of the refrigerated centrifuge. I started with detail study of medical laboratory instruments with my focus on the importance of centrifuge and applications in handling of sample and separation. I used this knowledge for exploring the concept of a refrigerated centrifuge and understanding its physical structure, refrigeration setup and basic working principles. I was the leader of my team and my position in the organizational structure is shown in the provided organogram (Figure 1). I played an important role in coordinating and directing the project activities. I worked with three of my other classmates who also contributed to the project. My project supervisors, [redacted], provided me guidance and support.

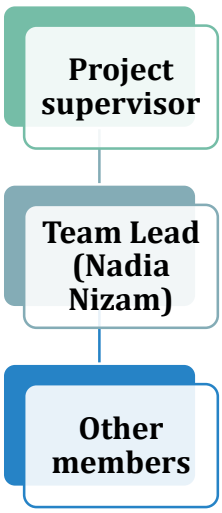

Figure 1: Hierarchy

CE 3.5 I oversaw and supervised the project. I managed and coordinated the tasks of teammates. I monitored the progress and ensured that we meet our objectives. I worked on structuring and formatting all tasks related to project. I compiled the documents and completed the final year project report. I chose the project idea and conducted research on the topic of refrigerated centrifuges. I created block diagram and

made circuit connections by selecting suitable components. I applied all my theoretical knowledge of engineering principles, technical expertise and problem-solving skills in overcoming the challenges and successfully completing the refrigerated centrifuge.

Personal Engineering Activity

CE 3.6 I coordinated and oversaw the activities of project. I applied my engineering knowledge to work on the project and move it further while making sure that I achieve the desired objectives within the assigned time period. I did research on refrigerated centrifuges, designing the connections of circuit selecting and procuring the components and assembling them to form a final prototype.

CE 3.7 I carried out detailed literature review for gaining understanding of the topic an its applications in medical laboratories. I studied the scientific papers, technical manuals and other reports of industry. I started my research with medical laboratory instruments. I found this instrument to be widely used in various medical settings hospitals, research labs and also for personal use. I gained an understanding of the applications of the medical centrifuge with the separation of blood samples, DNA/RNA separation, cell culture separation and its role in studying proteins, viruses, polymers, nucleic acids and blood. These applications helped me in understanding the significance of refrigerated centrifuges in medical laboratories in serving the needs of patients, doctors and students.

CE 3.8 I also studied about the refrigerated centrifuges which are a variant of the medical centrifuge with added features. These centrifuges are used in analysis of DNA, RNA, PCR and other antibody-related procedures. I found that technological advancements have made these refrigerated centrifuges more user-friendly. I also studied the physical structure of a refrigerated centrifuge which included essential components rotor, test tube holder, shaft, main chamber, compressor, condenser and piping. I researched the necessary refrigeration setup for modifying an ordinary clinical centrifuge into a refrigerated centrifuge. The setup consisted of four key components: compressor, condenser, evaporator and throttling device. I focused on understanding the operation of the throttling device, which is vital for generating cold liquid. I carried out a complete analysis of its workings as well as the operational characteristics of the other three components.

CE 3.9 I also understood and learned about the required materials and methods for developing a refrigerated centrifuge. I divided this instrument into three main parts: refrigeration, switching and the body with every category comprised of specific components. I discovered the hardware details of the project which provided me with understandings of effective and convenient modification of the ordinary centrifuge into a refrigerated one. I analyzed existing designs and functionalities. I also identified the key components and features required for the refrigeration system. This knowledge formed the basis for technical specifications and design goals of my project.

CE 3.10 I created block diagrams as well as circuit connections for the refrigeration system. I used my understanding of electrical and electronic principles and designed the circuitry required for controlling the refrigeration unit and maintaining the desired temperature inside the centrifuge. I selected suitable sensors, actuators and control systems while considering factors of power consumption, reliability and safety.

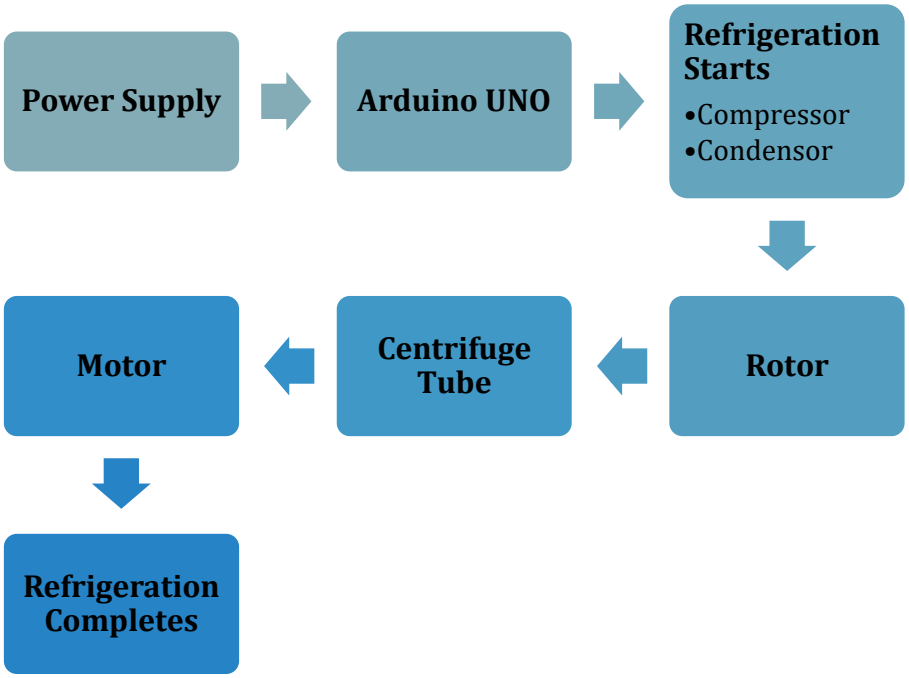

Figure 2: Block Diagram of Refrigerated Centrifuge

CE 3.11 I used my technical expertise and successfully developed a connection diagram on software which involved interfacing Arduino UNO with an LCD and temperature sensors. I established connection between the Arduino UNO circuit and a relay. This connection allowed me to control an electrical circuit by opening and closing contacts in different circuit. I used LM35 temperature sensor with the Arduino UNO for maintaining temperature and detecting temperatures up to 4^0C. I also implemented temperature control using the LM35 sensor. I connected LCD to the Arduino UNO for displaying the measurements of temperature, title of project and names of the group members. It helped me in clear and convenient monitoring of the temperature readings and made sure that the project information was readily available.

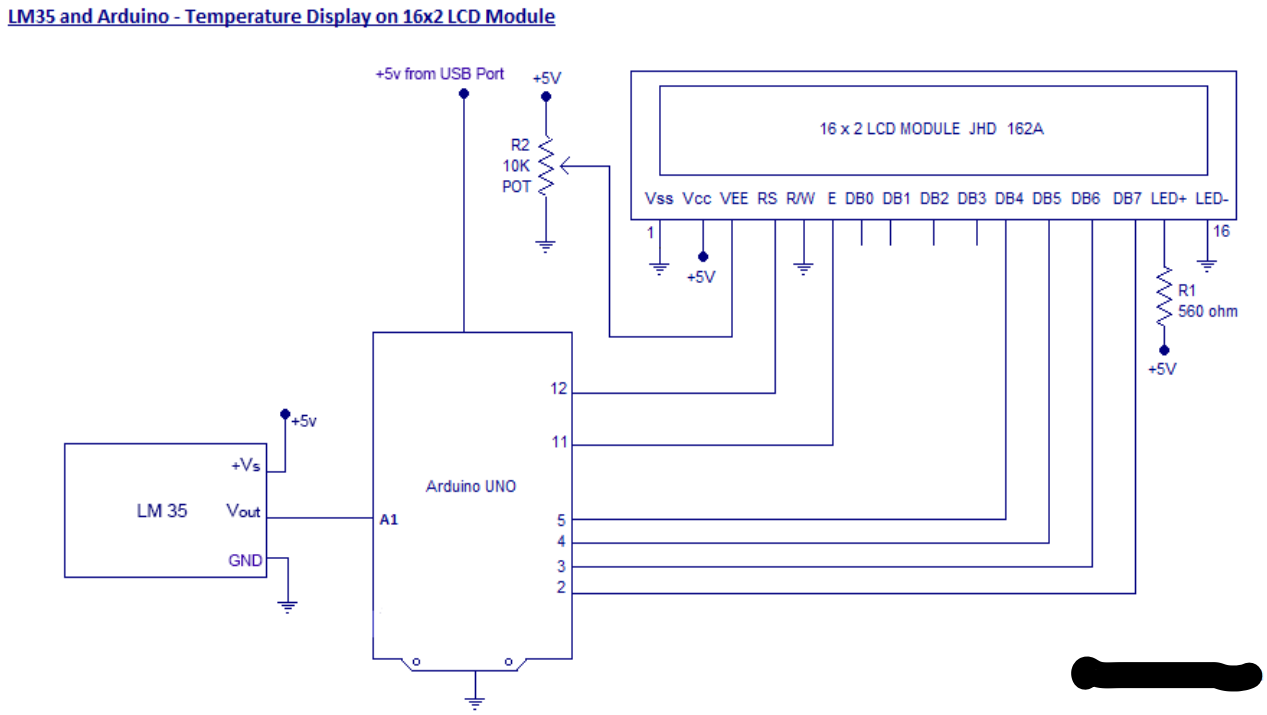

Figure 1: Interfacing Arduino UNO with LCD and Temperature sensor

CE 3.12 I selected the components for my project. Using the concept and block diagrams I determined the hardware specifications of three parts of the instrument; refrigeration, switching and body. I selected a condenser that operated on 220 volts and 50 Hz with a power rating of 50 watts for developing the

refrigeration part. The condenser played a critical role in cooling substances from a gaseous state to a liquid state. I also chose a compressor for reducing volume through an increase in gas pressure.

CE 3.13 I opted for an Arduino UNO microcontroller, a voltage regulator, an LCD display and switch buttons for the switching circuit. The Arduino UNO based on the ATMega 328P chip served as the core component. I selected a 16x2 display LCD for providing clear visual feedback. I used LM35 temperature sensor along with appropriate voltage regulation for measuring temperature. The switch buttons I included helped in user interaction and control.

CE 3.14 Moving to the body part of the system, I selected a rotor having a diameter of 12 inches. This rotor had a capacity for accommodating almost six test tubes with each having half an inch of space. I chose a test tube holder of 1.8 inches in diameter and 3.8 inches in height. For structural stability, I used a 0.5-inch diameter shaft that was 12 inches long. For piping I used discharge piping to expel gas from the compressor to the condenser, liquid-type piping for transporting condensed liquid to the expansion device and section-type piping for transporting gas from the evaporator section. I chose cost-effective components for my project without compressing on the quality. I searched for various sources to get reasonable and desirable components for my project.

CE 3.15 I also faced few challenges during the implementation phase of this project. One of them was integration of refrigeration system with existing centrifuge without compromising the structural integrity and functionality. I properly positioned the cooling components and insulated them for avoiding any interference with the centrifugal operation as well as sample handling processes. I devised an efficient layout that maximized cooling performance while maintaining the core functionality of centrifuge by planning and prototyping.

CE 3.16 Another issue I faced was optimization of performance of the refrigerator system for achieving the precise temperature control. To overcome this issue, I carried out experiments for evaluating the cooling efficiency, thermal stability and response time of the system. I then analysed the results and made iterative adjustments to the control algorithms. By doing this I fine-tuned the system and achieved the desired temperature range with minimal fluctuations.

CE 3.17 I also considered the safety measures and ensured user-friendly operation of the refrigerated centrifuge. I implemented failsafe mechanisms for preventing overheating or overcooling. I integrated alarms for temperature deviations and applied user-friendly interfaces for settings and monitoring of temperature. I was able to enhance the reliability and usability of the system by ensuring its suitability for real-world laboratory environments.

CE 3.18 Effective collaboration and teamwork were essential for success of this project. I worked with my team members who participated as per their expertise in areas of mechanical design, prototyping and software development. I arranged regular meetings for discussion of progress, addressing challenges and sharing ideas. I established clear communication channels for carrying out effective information exchange and decision-making.

CE 3.19 I created a motivating work environment which encouraged my teammates to freely express their ideas and suggestions. This helped in implementation of variety of perspectives and enabled us to recognise innovative solutions to complex problems. I utilized the strengths of each team member and encouraged them for knowledge-sharing. I achieved synergy in our collective efforts which lead to a more efficient and successful outcome of project.

Summary

CE 3.20 In summary, I worked on a project of converting a clinical centrifuge into a refrigerated centrifuge. Aim of this project was to enhance the functionality of the centrifuge by implementing refrigeration capabilities. This enabled temperature-sensitive samples to be processed with greater precision and reliability. I was successful in meeting goals and requirements of the project. The refrigerated centrifuge I transformer showed improved performance in maintaining the desired range of temperature. It also provided a stable and controlled environment for sensitive samples. I also implemented safety features and user-friendly interfaces for ensuring the reliability of system as well as ease of operation in laboratory settings.

CE 3.21 I was the leader of the team and played an important role in success of this project. I used my engineering expertise to conduct research, conceptualize and execute the design of the refrigeration system. I overcame technical difficulties, optimized the system's performance and ensured its compatibility with

the existing centrifuge structure by diligent problem-solving and innovative thinking. My contributions were instrumental in designing the circuit connections, selecting suitable components and coordinating the team's effort. I promoted open dialogue and knowledge-sharing in my team which harnessed the variety of perspectives within the team and lead to creative solutions and a cohesive project outcome.