

## PROFESSIONAL TRAINING - 1

Submitted in partial fulfillment of the requirements for the award of  
Bachelor of Technology degree in Biomedical Engineering

By Swetha G,

(41240037)



DEPARTMENT OF BIOMEDICAL ENGINEERING  
SCHOOL OF BIO AND CHEMICAL ENGINEERING

# **SATHYABAMA**

INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)

Accredited with grade "A++" by NAAC

JEPPIAR NAGAR , RAJIV GANDHI SALAI, CHENNAI -600 119

OCT – 2023



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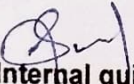
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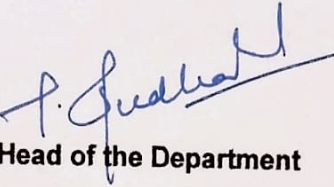
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### BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Swetha G (41240037)  
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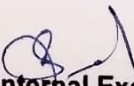
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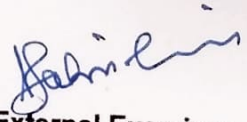
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# TRAINING CERTIFICATES



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THIS IS PRESENTED TO  
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for their participation in the Online Internship on  
"Bio-Electric Signals Training "  
at MedCuore Medical Solutions Pvt Ltd, Chennai  
From 19-06-2023 to 23-06-2023

**ONLINE TRAINING DURATION: ONE WEEK**  
Topics Covered: Introduction of Bioelectric signals, Blood Pressure Monitoring, ECG, EEG,  
Patient Monitor, and EMG.

  
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Certificate Number: 10352918

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Certificate Issue Date - 27-06-2023



DATE: 28.09.2023

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This is to certify that **MS.SWETHA G** of **B.TECH-BIOMEDICAL ENGINEERING**, Sathyabama Institute Of Science And Technology Has Attended Her Internship At GEM SCAN, Maraimalai Nagar, Tamilnadu-603 209.

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Signature/Stamp



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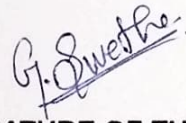
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## DECLARATION

I **Swetha.G** hereby declare that the professional training report completed by me during my professional training at Gem scans and medcuore under the guidance of **Dr. A. Sabarivani** (internal), **Ms. Sindu Divakaran** (external) is submitted in partial fulfillments of the requirements for the award of degree in Bachelor of Technology degree in Biomedical Engineering.

**DATE:** 03.10.2023

**PLACE :**CHENNAI

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**SIGNATURE OF THE CANDIDATE**

## ACKNOWLEDGEMENT

I wish to express my most sincere and profound gratitude to our beloved **Founder Chancellor Col.Dr. JEPPIAR,M.A.,B.L.,Ph.D.**, for providing me an opportunity to educate myself.

I am also pleased to acknowledge sincere thanks to our **Chancellor Dr. MARIAZEENA JOHNSON, B.E.,M.B.A.,M.Phil.,Ph.D.** and President **Dr. MARIE JOHNSON, B.E., M.B.A., M.Phil., Ph.D.** and our beloved Vice Presidents **Mr.J.ARUL SELVAN,Ms. MARIA BERNADETTE TAMILARASI, Ms. MARIA CATHERINE JAYAPRIYA** of Sathyabama Institute of Science and Technology, Chennai, for their unwavering support to carry out my research work.

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I would like to extend my thanks to **Dr.B.SHEELA RANI ,M.S., Ph.D.**, Director (research),Our Dean of school of Bio and Chemical sciences **DR. RAMESH KUMAR, M.Sc., Ph.D.** our head of the department **Dr. T. Sudhakar M.Sc., Ph.D.**, and our professional training guides **Ms. SINDU DIVAKARAN** and **Dr. A. SABARIVANI , M.Tech., Ph.D.** Thank you for being a part of this educational journey with us.

And I wish to express my thanks to all the Teaching and Non-Teaching staff members of the department of biomedical engineering who were helpful in many ways for the completion of the report.

## **ABSTRACT**

This abstract highlights a professional training program at Gem Scans, where in-depth knowledge about medical equipment, including CT, ultrasound, X-ray, lab tests, and ECG, was acquired. Additionally, they honed their skills in collecting and analyzing blood samples and interpreting electrocardiograms. This training equipped me with the knowledge and practical skills required to contribute effectively to accurate medical diagnoses and patient care.

I have also highlighted some of the knowledge I gained during my online professional training by Medcuore. This online professional training program focused on the measurement of physiological signals and the operation of critical medical monitoring equipment. Participants gained expertise in bioelectric potential measurement, patient monitoring systems, and the use of devices such as ECG, EEG, EMG, and blood pressure monitors. This training equipped me with essential skills to interpret bioelectric signals, perform ECG recordings, monitor brainwave activity, assess muscle and nerve function, and measure blood pressure.

In conclusion, my internship training at Gem scans not only provided a platform for practical learning but also ignited a passion for the field of biomedical engineering. It is my hope that this report serves as a testament to the valuable experiences gained during this internship and the valuable contributions of biomedical engineers in advancing healthcare

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# INTRODUCTION

## 1.1 DIAGNOSTIC INSTRUMENTS

Diagnostic instruments are essential tools used in various fields of medicine, science, engineering, and other industries to assess and identify specific conditions, parameters, or characteristics of a subject, system, or environment. These instruments play a crucial role in gathering precise and reliable data, aiding in decision-making, and ultimately improving outcomes. They come in various forms and serve a wide range of purposes, from healthcare and automotive diagnostics to environmental monitoring and quality control in manufacturing. This introduction will provide an overview of diagnostic instruments, their types, and their importance in different applications.

In healthcare, diagnostic instruments are used to assess patient's health conditions and aid in disease diagnosis and monitoring. Examples include stethoscopes, blood pressure monitors, thermometers, X-ray machines, MRI scanners, and blood analyzers. Laboratory Diagnostic Instruments are used in research and clinical laboratories to analyze samples and perform tests. Examples include microscopes, spectrophotometers, centrifuges, and PCR machines for genetic analysis.

In the automotive industry, diagnostic tools help identify and troubleshoot issues in vehicles. OBD-II (On-Board Diagnostics) scanners, for instance, read diagnostic trouble codes (DTCs) to pinpoint problems. Environmental Monitoring Instruments are crucial for assessing environmental conditions and detecting pollutants. Examples include air quality monitors, water quality analyzers, and weather stations.

In manufacturing and industrial settings, diagnostic instruments are used to maintain quality control, identify defects, and ensure the efficient operation of machinery. Examples include vibration analyzers, infrared cameras, and ultrasonic testing equipment. In electronics and electrical engineering, diagnostic tools help diagnose

faults in electronic circuits and devices. Examples include oscilloscopes, multimeters, and logic analyzers.

## 1.2 BIOMEDICAL DEVICES

Biomedical devices have a rich history spanning from ancient civilizations to the modern era. Early medical instruments, such as scalpels and forceps, were employed by cultures like the Egyptians, Greeks, and Romans. In the 17th century, the advent of microscopes, pioneered by scientists like **Antonie van Leeuwenhoek**, laid the foundation for microbiology. Fast forward to the 19th century, when **René Laennec's** invention of the stethoscope revolutionized diagnostic medicine.

The 20th century witnessed a remarkable surge in technological advancements. X-ray machines, following **Wilhelm Conrad Roentgen's** discovery of X-rays in 1895, became pivotal for diagnosing internal conditions. Electrocardiograms (ECGs) emerged as a crucial tool for recording heart activity. Ultrasonography, developed mid-century, allowed non-invasive visualization of internal structures. The 1970s introduced computed tomography (CT) scanners, providing detailed cross-sectional images. Magnetic resonance imaging (MRI), using magnets and radio waves, offered high-resolution soft tissue imaging.

In the 21st century, biomedical devices have undergone further evolution. Wearable health devices like smartwatches and fitness trackers have empowered individuals to monitor their health metrics. **Telemedicine**, enabled by advanced communication technology, facilitates remote patient monitoring and consultations. Miniaturized implantable devices, such as pacemakers and neural prosthetics, enhance patient outcomes. **Nanotechnology** promises targeted therapies and diagnostics at the molecular level. Artificial intelligence (AI) drives diagnostic and predictive tools, while 3D printing technology allows for the customization of biomedical devices. Robotics assists in surgery and rehabilitation, improving precision and patient recovery.

Throughout history, biomedical devices have played an increasingly vital role in healthcare, driving innovation and expanding possibilities for diagnosis, treatment, and patient care. From ancient tools to modern marvels, these devices reflect a journey of continuous progress and an enduring commitment to improving human health and well-being.

## DIAGNOSTIC EQUIPMENTS

### 2.1 COMPUTED TOMOGRAPHY

Computed Tomography (CT), often referred to as a CT scan or CAT scan, is a medical imaging technique that uses X-rays and computer technology to create detailed cross-sectional images of the body's internal structures.

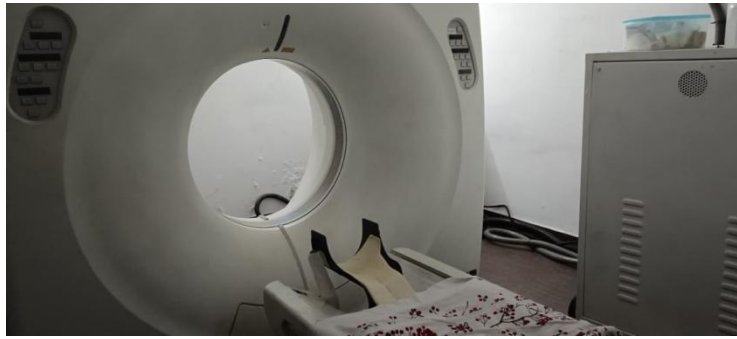


***Fig 2.1: computed tomography***

CT, or Computed Tomography, is a medical imaging technique that uses X-rays and computer processing to create detailed cross-sectional images of the body. It is also sometimes referred to as a CAT scan (Computed Axial Tomography). CT scans are valuable tools for diagnosing a wide range of medical conditions and injuries.

#### **2.1.1 PRINCIPLE:**

CT imaging is based on the principle of X-ray attenuation. When X-rays pass through the body, different tissues and structures attenuate (weaken) the X-ray beams to varying degrees. Dense tissues like bones attenuate X-rays more than soft tissues like muscles and organs. CT takes advantage of these differences in attenuation to create detailed images.



***Fig 2.2: CT Machine***

### **2.1.2 WORKING:**

- Emitting X-rays through the body.
- Capturing X-ray projections from multiple angles.
- Processing and combining these projections using computer algorithms.
- Generating cross-sectional images (slices) of the body.
- Displaying these images for medical diagnosis and evaluation.

### **2.1.3 APPLICATIONS:**

- Diagnosing injuries and diseases in various body parts.
- Evaluating the brain for strokes and tumors.
- Detecting lung conditions, such as cancer and pneumonia.
- Assessing abdominal organs, like the liver, kidneys, and intestines.
- Examining the bones and joints for fractures and arthritis.
- Guiding surgeries and interventions.
- Monitoring the progression of diseases and treatments.
- Visualizing blood vessels for vascular studies.
- Planning radiation therapy for cancer treatment.
- Investigating trauma and identifying internal injuries.

## 2.2 ULTRASOUND

Ultrasound, also known as ultrasonography, is a medical imaging technique that uses high-frequency sound waves to create images of the inside of the body. It is a non-invasive and safe diagnostic tool that has a wide range of medical applications.



***Fig 2.3: Ultrasound***

### 2.2.1 PRINCIPLE:

Ultrasound imaging, also known as sonography, relies on the principle of sending high-frequency sound waves into the body and capturing the echoes produced when these waves bounce off internal structures.

### 2.2.2 PROBES:



**Fig 2.4: Ultrasound probes**

#### ***Linear probe:***

- **Use:** For imaging superficial structures and vascular studies.
- **Applications:** Visualizing muscles, tendons, thyroid, breast, and blood vessels near the surface.

#### ***Curvilinear (convex) probe:***

- **Use:** For deep structure imaging, abdominal, and obstetric exams.
- **Applications:** Ideal for liver, kidney, uterus, and fetal imaging during pregnancy.

#### ***Phased array probe:***

- **Use:** Commonly used in cardiac and vascular imaging.
- **Applications:** Evaluating the heart's structure and function (echocardiography) and assessing blood flow in arteries and veins.

### 2.2.3 WORKING:

Ultrasound works by emitting high-frequency sound waves into the body. These sound waves bounce off internal structures, creating echoes that are detected and

processed by the ultrasound machine. The machine then generates real-time images based on these echoes, allowing healthcare professionals to visualize and assess the internal organs and tissues.



***Fig2.5: Ultrasound Machine***

#### **2.2.4 APPLICATIONS:**

- **Obstetrics:** Monitoring fetal development during pregnancy.
- **Abdominal Imaging:** Assessing organs like the liver and kidneys.
- **Cardiac Imaging:** Evaluating the heart's structure and function.
- **Vascular Studies:** Examining blood flow in arteries and veins.
- **Musculoskeletal:** Visualizing muscles, tendons, and joints.
- **Breast Imaging:** Detecting breast abnormalities.
- **Thyroid Evaluation:** Assessing the thyroid gland.
- **Guiding Procedures:** Assisting with biopsies and interventions.
- **Ophthalmology:** Imaging the eye for various conditions

## 2.3 X RAY

X-ray, also known as radiography, is a medical imaging technique that uses electromagnetic radiation to create images of the inside of the body.



***Fig 2.6: X ray machine***

### **2.3.1 WORKING:**

- Emitting X-rays from a tube.
- X-rays pass through the body.
- A detector records the X-rays that emerge.
- Dense structures like bones absorb more X-rays, creating contrast.
- The data is processed to create a two-dimensional X-ray image, which reveals the internal anatomy.



***Fig 2.7: Standing X Ray***



***Fig 2.8: Dental X Ray***



***Fig 2.9: Sitting X Ray***

### **2.3.2 APPLICATIONS:**

- Detecting bone fractures and injuries.
- Examining the chest for lung and heart conditions (chest X-ray).
- Evaluating dental health (dental X-rays).
- Diagnosing and monitoring diseases like pneumonia and tuberculosis.
- Guiding the placement of medical devices or procedures (fluoroscopy).

## 2.4 ELECTROCARDIOGRAM

ECG stands for Electrocardiogram, which is a widely used medical test that records the electrical activity of the heart over a period of time.



**Fig 2.10: ECG machine**

There are two types of leads that are attached to the patient:

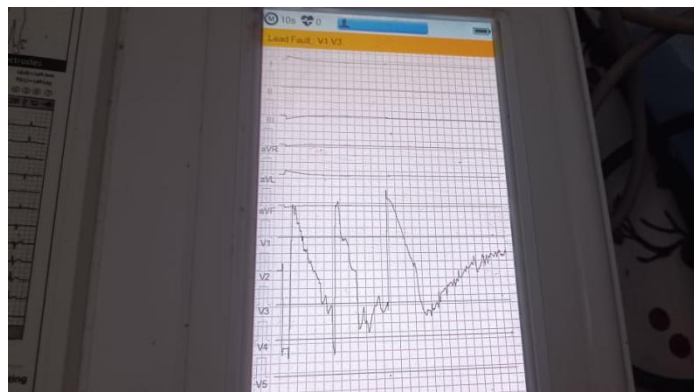
### **2.4.1 LIMB LEADS (BIPOLAR LEADS):**

- **Lead I:** This lead records the electrical difference between the right arm (RA) and left arm (LA).
- **Lead II:** It records the electrical difference between the right arm (RA) and left leg (LL).
- **Lead III:** This lead records the electrical difference between the left arm (LA) and left leg (LL).
- **Augmented Vector Left (aVL):** It measures the electrical activity between the left arm (LA) and a virtual reference point that is the average of the right arm (RA) and left leg (LL).
- **Augmented Vector Right (aVR):** It measures the electrical activity between the right arm (RA) and a virtual reference point that is the average of the left arm (LA) and left leg (LL).
- **Augmented Vector Foot (aVF):** This lead measures the electrical activity between the left leg (LL) and a virtual reference point that is the average of the right arm (RA) and left arm (LA).

### **2.4.2 PRECORDIAL LEADS (UNIPOLAR LEADS):**

These leads are placed on specific locations on the chest.

- **V1:** Positioned at the 4th intercostal space just right of the sternum.
- **V2:** Placed at the 4th intercostal space just left of the sternum.
- **V3:** Positioned halfway between V2 and V4.
- **V4:** Placed at the 5th intercostal space in the midclavicular line.
- **V5:** Positioned at the 5th intercostal space at the anterior axillary line.
- **V6:** Placed at the 5th intercostal space at the midaxillary line.



**Fig 2.11: ECG Reading**

### **2.4.3 APPLICATIONS:**

- Diagnosing heart conditions.
- Monitoring heart health during check-ups.
- Assessing cardiac function during surgery.
- Detecting abnormal heart rhythms.
- Evaluating the effectiveness of cardiac medications.
- Identifying signs of heart attack or ischemia.
- Guiding treatment for arrhythmias and heart diseases.
- Screening for heart issues in at-risk individuals.
- Monitoring patients in intensive care units.
- Assessing the impact of physical stress on the heart during exercise test.

## LAB TEST EQUIPMENTS

### 3.1 LABORATORY CENTRIFUGE

A laboratory centrifuge is a specialized piece of equipment used in scientific and medical laboratories to separate substances of different densities or sizes from liquid suspensions. It operates on the principle of centrifugal force, which is the outward force experienced by objects in rotation.



***Fig 3.1: Laboratory centrifuge***

#### **3.1.1 WORKING:**

- Laboratory centrifuge rapidly rotates samples in a rotor.
- Centrifugal force is generated, pushing heavier components outward.
- Lighter components remain closer to the center.
- This separation is based on differences in density or size.
- Substances like cells, proteins, or particles are effectively separated.
- Separated components can be further analyzed or processed.



***Fig 3.2: Centrifuge***

### **3.1.2 APPLICATIONS:**

- Separating blood components like plasma, red blood cells, and platelets.
- Purifying DNA, RNA, and proteins in molecular biology research.
- Concentrating samples, such as isolating viruses or bacteria.
- Analyzing and separating particles in environmental research.
- Separating and purifying pharmaceutical compounds.
- Preparing samples for diagnostic tests in clinical laboratories.
- Separating cellular components for cell culture studies.
- Analyzing and separating colloids and suspensions in chemistry.
- Purifying and isolating specific organelles in cell biology.
- Separating lipoproteins in lipid metabolism studies.

## 3.2 BIOCHEMISTRY ANALYZER

A biochemistry analyzer, also known as a clinical chemistry analyzer or a chemistry analyzer, is a medical laboratory instrument used to perform a wide range of biochemical tests on various biological samples, such as blood, serum, plasma, urine, and cerebrospinal fluid. These tests help healthcare professionals diagnose and monitor various medical conditions and assess the functioning of organs and systems in the body.



***Fig 3.3: Biochemistry analyzer***

### 3.2.1 WORKING:

- A biochemistry analyzer handles patient samples like blood or urine.
- Multiple samples can be processed simultaneously.
- Proper sample identification is essential.
- Reagents are added to the samples to initiate chemical reactions.
- Reactions involve enzymes, substrates, and antibodies specific to analytes.
- Mixing and incubation steps ensure thorough reactions.
- Chemical reactions vary based on the specific tests.
- Optical sensors or detectors measure the intensity of reactions.
- Intensity correlates with analyte concentration in the sample.
- Light absorption, fluorescence, or chemiluminescence can be used for detection.

- The analyzer processes data from detectors, using calibration curves or algorithms.
- Data is converted into concentration values for the analytes.
- Quality control samples run alongside patient samples.
- Regular calibration and maintenance are vital for accuracy.
- Electronic reports with test results are generated.
- Reports can be printed or sent to a laboratory information system (LIS).
- Results are interpreted by healthcare professionals for diagnosis or treatment.
- Maintenance involves changing reagent packs, cleaning fluid pathways, and verifying calibration to ensure accuracy.



**Fig 3.4: Biochemistry analyzer Machine**



**Fig 3.5: Blood sample report**

### **3.2.2 APPLICATIONS:**

- Diagnosing and monitoring diseases.
- Assessing organ function (e.g., liver and kidney).
- Measuring glucose and lipid levels.
- Monitoring cardiac markers.
- Evaluating electrolyte and protein levels.
- Detecting autoimmune disorders.
- Screening for drug and medication levels.
- Assessing nutritional and metabolic status.
- Research in pharmaceutical and biotechnology fields.
- Quality control in food and beverage industries.

### 3.3 BLOOD SAMPLE ROLLER MIXER

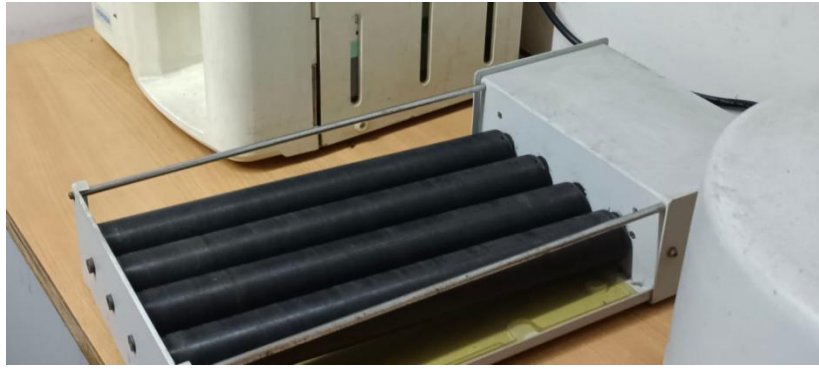
A blood sample roller mixer is a laboratory instrument designed to gently and uniformly mix blood samples or other liquid samples contained in tubes or vials. It is commonly used in clinical laboratories, research settings, and medical facilities for tasks that require thorough and consistent mixing of blood or other biological samples.



***Fig 3.6: Blood sample mixer***

#### **3.3.1 WORKING:**

- Blood sample mixers use a roller mechanism.
- Tubes or vials containing blood samples are placed on the rollers.
- The instrument rotates the tubes gently and continuously.
- This rotation ensures thorough mixing of the samples.
- Gentle mixing prevents clot formation or sedimentation.
- Many mixers offer adjustable speed settings.
- Users can control the mixing intensity by adjusting the speed.
- Mixers are versatile and accommodate various tube sizes.
- They are commonly used in clinical and research laboratories.
- Regular maintenance is required to prevent contamination and ensure longevity.



***Fig 3.7: Blood sample mixer roller***

### **3.3.2 APPLICATIONS:**

- Ensuring uniform mixing of blood samples for coagulation studies.
- Homogenizing samples for chemistry and immunoassay tests.
- Preparing samples for serology and immunology assays.
- Maintaining bacterial or cell cultures in suspension.
- Consistent temperature incubation for kinetic assays.
- Used in clinical labs, research labs, and healthcare facilities.
- Crucial for accurate diagnostic tests and research outcomes.
- Preventing clot formation and sedimentation in blood samples.
- Vital for reliable and reproducible test results.
- Supporting sample preparation in various scientific and medical settings.

## **CONCLUSION**

In conclusion, my journey through the professional training program focused on biomedical devices has been both enlightening and rewarding. Over the course of this program, I have gained a comprehensive understanding of a wide range of crucial medical equipment, including CT scanners, ultrasound machines, ECG monitors, X-ray machines, laboratory centrifuges, biochemistry analyzers, and blood sample mixers. This training has equipped me with the knowledge and skills necessary to operate, troubleshoot, and maintain these devices effectively, ensuring their optimal performance in clinical settings. I have learned the intricacies of how each of these instruments functions, their unique applications in healthcare, and the critical role they play in diagnosing and treating medical conditions.

As I move forward in my career, the knowledge and expertise I have gained from this training will undoubtedly contribute to better patient outcomes and enhance the efficiency of healthcare facilities. I am excited to apply these skills in a clinical setting, collaborate with healthcare professionals, and make a meaningful contribution to the field of biomedical technology.

I extend my gratitude to the instructors and mentors who have guided me throughout this program, and I am eager to continue my professional development in the ever-evolving field of biomedical devices. This training has laid a strong foundation for my future endeavors, and I am confident that it will serve as a valuable asset in my career in healthcare.

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