VISVESVARAYA TECHNOLOGICAL UNIVERSITY

GnanaSangama, Belgaum – 590002, Karnataka

A
PROJECT WORKON

"IMPLEMENTATION OF AN OFF-HOSPITAL RURAL AND URBAN PUBLIC ACCESS DEFIBRILLATOR"

Carried out
By

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Submitted in partial fulfilment for the award of

BACHELOR OF ENGINEERING IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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Certificate

This is to certify that the project work entitled

"IMPLEMENTATION OF AN OFF-HOSPITAL RURAL AND URBAN PUBLIC ACCESS DEFIBRILLATOR"

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is a bonafide work carried out at K.S. institute of Technology, Bangalore, in partial fulfilment for the award of degree in Bachelor of Engineering, in Electronics and Communication Engineering from Visvesvaraya Technological University, Belgaum during the year 2019-2020. It is certified that all corrections and suggestions indicated during internal assessment have been incorporated inthereportdepositedinthedepartmentlibrary.Theprojectreporthasbeenapprovedasitsatisfies the academic requirements in respect of Project Work prescribed for Bachelor of Engineering Degree.

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DECLARATION

We, Madhu G USN:1KS16EC044, Sahana D USN:1KS16EC079 and Sahana K G USN:1KS16EC080, students of 8thsemester B.E., Department of Electronics and Communication Engg., K.S. Institute of Technology, Bengaluru declare that the project entitled "Implementation Ofan off-hospital rural and urban public access defibrillator"hasbeencarriedoutbyusandsubmitted in partial fulfilment of the course requirements for the award of degree in B.E. in Electronics and Communication, Visvesvaraya Technology University, Belgaum during the academic year 2019-2020. Further, the matter embodied in dissertation has not been submitted previously by anybody for the award of any Degree or Diploma to any other University.

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ABSTRACT

The occurrence of out-of-hospital cardiac arrest (OHCA) is a critical life-threatening event that often warrants initial defibrillation with a semi-automated external defibrillator (SAED). In INDIA, about 4280 deaths in 1Lakh are due to SCA. The optimization of allocating a limited number of SAEDs in various types of communities is challenging.

Hence this presents the implementation of an off-hospital rural and urban public access defibrillators. This defibrillator is a semi-automated defibrillator, a medical device which analyse the patient's electrocardiogram in order to establish whether he/she is suffering from ventricular fibrillation and if necessary, delivers an electric shock, or defibrillation, to help the heart re-establish an effective rhythm.

Keywords: Semi-automated external defibrillator, Electrocardiogram, Ventricular Fibrillation, Defibrillation.

CHAPTER 1

INTRODUCTION

Amongst the most impending health challenges of modern society, the Sudden Cardiac Arrest (SCA) is probably one of the deadliest. SCA alone is responsible every year for over 300’000 deaths in the United States. As a mean of comparison, his number is greater than the combined number of those who die from Alzheimer’s disease, assault with firearms, breast cancer, cervical cancer, colorectal cancer, diabetes, HIV, house fires, motor vehicle accidents, prostate cancer, and suicides.

SCA is a condition in which the heart suddenly and unexpectedly stops beating in an ordered fashion way, and instead start exhibiting a chaotic behaviour. When this happens, blood stops flowing to the brain and other vital organs. In these conditions the patient may be considered to all effects dead, and will remain so unless someone help him/her immediately. The most effective way to treat a SCA is with defibrillation, namely a therapeutic dose of electrical energy. The necessity of performing defibrillation as soon as possible -in order to significantly raise the chance of resuscitations led to the development of Automated External Defibrillators (AED).

AEDs are portable devices capable of automatically diagnose whether a patient is experiencing SCA or not, and treat him/her through defibrillation when needed. The critical aspect of AEDs, is the ease of use that allow their operation with a very basic training.

Fortunately, SCA is reversible in most victims if it's treated within few minutes with an electric shock to the heart to restore the normal heartbeat. This process is called defibrillation. In fact, defibrillation is the definitive treatment for this life threatening arrhythmia. The first defibrillator (Figure 1.1) was developed by Claude Beck in 1947 and used spoons as electrodes. Major advances in defibrillation have been made and have resulted in the development of Automated External Defibrillators (AED) and Implantable Cardioverter defibrillators (ICD). AEDs (Figure 1.2) are automated devices which analyze the electrocardiogram (ECG) signal and advise a shock in case of ventricular fibrillation. ICDs are small devices which can be implanted beneath the skin and function automatically for several years.

Figure 1.1 Early Defibrillator

Figure 1.2 Modern AEDs

Sudden Cardiac Arrest

Sudden Cardiac Arrest is a condition in which the heart suddenly and unexpectedly stops beating. When this happens, blood stops flowing to the brain and other vital organs. In these conditions the patient may be considered to all effects dead, and will remain so unless someone help him/her immediately with cardiopulmonary resuscitation (CPR), defibrillation, advanced cardiac life support, and/or mild therapeutic hypothermia.

Although cerebral neurons can tolerate up to 20 minutes of normothermic ischemic anoxia, cerebral recovery from more than 5 minutes of cardiac arrest is hampered by complex secondary derangements of multiple organ systems after re-perfusion (The so called post-resuscitation syndrome). Therefore even if the victim could survive enough time for the medical team to arrive, the chances of post-resuscitation syndrome and further health issues -such as brain damages- drastically increases with time.

Causes

In SCA, as result of a bio-electrical dysfunction, the heart stops beating in an efficient, organized manner, and instead start manifesting a chaotic behavior. The pumping action thereby, becomes ineffective and the blood flow stops. It also often occurs in active people who seem to be healthy and have no known medical conditions. In fact, for some patients SCA is the first indication of a heart condition. SCA conditions can be diagnosed by watching the ECG.

Electrocardiography

Electrocardiogram (ECG) is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the skin. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electro-physiologic pattern of depolarizing during each heartbeat.

During each heartbeat, a healthy heart has an orderly progression of depolarization that starts with pacemaker cells in the sinoatrial node, spreads out through the atrium, passes through the atrioventricular node down into the bundle of His and into the Purkinje fibers, spreading down and to the left throughout the ventricles. This orderly pattern of depolarization gives rise to the characteristic ECG tracing (Figure 1.3). To the trained clinician, an ECG conveys a large amount of information about the structure of the heart and the function of its electrical conduction system.

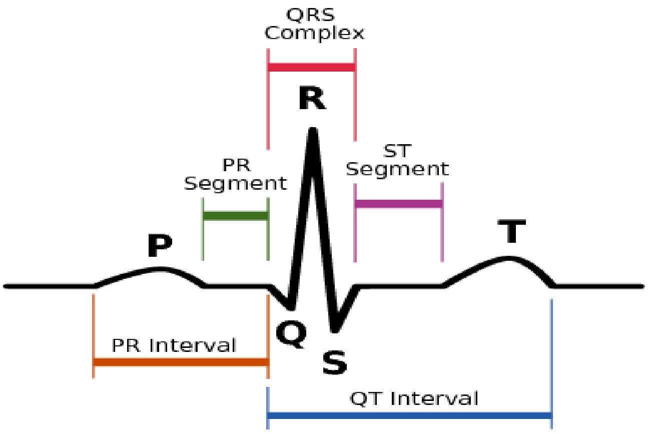

Figure 1.3: Schematic representation of normal ECG

Interpretation of the ECG is ultimately that of pattern recognition. Normal rhythm produces four entities (see Figure 1.3) that each have a fairly unique pattern:

1. the P wave represents atrial depolarization;
2. the QRS complex represents ventricular de-polarization;
3. the T wave represents ventricular re-polarization;
4. the U wave represents papillary muscle re-polarization.

Normal analysis of ECG tracks involves investigation of the shape, length, rate, and width of every segment.

Defibrillation

By definition, defibrillation consist of delivering a therapeutic dose of electrical current to the heart. This depolarizes a critical mass of the heart muscle, terminates the arrhythmia and allows normal sinus rhythm to be re-established by the heart’s natural pacemaker, in the Sino-atrial node.

In simple terms, defibrillation ”reset” the heart bio-electrical functionalities. By its nature, the heart has different fail-safe measures which ensure that once the synchronization is restored (e.g. with the defibrillation), then its pacing capabilities re-start in a ordered fashion way.

History of defibrillation

Defibrillators were first demonstrated in 1899 by Jean-Louis Prevost and ´ Fred´ ericBatelli, two physiologists from University of Geneva, Switzerland. ´ They discovered that small electrical shocks could induce ventricular fibrillation in dogs, and that larger charges would reverse the condition.

In 1933, Dr. Albert Hyman, heart specialist and C. Henry Hyman, an electrical engineer, looking for an alternative to injecting powerful drugs directly into the heart, came up with an invention that used an electrical shock in place of drug injection. This invention was called the Hyman Otor where a hollow needle is used to pass an insulated wire to the heart area to deliver the electrical shock. The hollow steel needle acted as one end of the circuit and the tip of the insulated wire the other end. Whether the Hyman Otor was a success is unknown.

The external defibrillator as known today was invented by Electrical Engineer William Kouwenhoven in 1930. William studied the relation between the electric shocks and its effects on human heart when he was a student at Johns Hopkins University School of Engineering. His studies helped him to invent a device for external jump start of the heart. He invented the defibrillator and tested on a dog, like Prevost and Batelli. The first use on a ´ human was in 1947 by Claude Beck, professor of surgery at Case Western Reserve University. Beck's theory was that ventricular fibrillation often occurred in hearts which were fundamentally healthy, in his terms ”Hearts that are too good to die”, and that there must be a way of saving them. Beck first used the technique successfully on a 14-year-old boy who was being operated on for a congenital chest defect. The boy's chest was surgically opened, and manual cardiac massage was undertaken for 45 minutes until the arrival of the defibrillator. Beck used internal paddles on either side the heart, along with procainamide, an antiarrhythmic drug, and achieved return of normal sinus rhythm.

These early defibrillators used the alternating current from a power socket, transformed from the 110–240 volts available in the line, up to between 300 and 1000 volts, to the exposed heart by way of ”paddle” type electrodes. The technique was often ineffective in reverting VF while morphological studies showed damage to the cells of the heart muscle post mortem. The nature of the AC machine with a large transformer also made these units very hard to transport, and they tended to be large units on wheels.

Until the early 1950s, defibrillation of the heart was possible only when the chest cavity was open during surgery. The closed-chest defibrillator device which applied an alternating voltage of greater than 1000 volts, conducted by means of externally applied electrodes through the chest cage to the heart, was pioneered by Dr V. Eskin with assistance by A. Klimov in Frunze, USSR (today known as Bishkek, Kyrgyzstan) in the mid-1950s.

A major breakthrough was the introduction of portable defibrillators used out of the hospital. In Soviet Union, a portable defibrillator, named DPA-3, was reported in 1959. In the western countries this was pioneered in the early 1960s by Prof. Frank Pantridge in Belfast. Today portable defibrillators are among the many very important tools carried by ambulances. They are the only proven way to resuscitate a person who has had a cardiac arrest unwitnessed by Emergency Medical Services (EMS) who is still in persistent ventricular fibrillation or ventricular tachycardia at the arrival of pre-hospital providers.

Gradual improvements in the design of defibrillators, partly based on the work developing implanted versions, have led to the availability of AEDs.

AED

When sudden cardiac arrest strikes, time is critical; survival is reduced by 10% for each minute that defibrillation is delayed). Brain death and permanent death start to occur in just four to six minutes after someone experiences cardiac arrest. Total response time from the time a medical emergency call is made until arrival of units and application of defibrillator often reaches 8-9 minutes. As a result, 95% of victims die before emergency personnel arrive. SCA is reversible in most victims if it's treated within a few minutes with an electric shock to the heart to restore a normal heartbeat.

Use of manual defibrillators requires considerable amount of training especially in interpreting the ECG and since cardiac incidents occur most often out of hospital automated external defibrillators (AEDs) were introduced to increase the survival rate. Use of AEDs requires no training and therefore they can be used in public places by untrained bystanders. In fact, having an AED on site is rapidly becoming a basic standard of emergency care, equivalent to having a smoke alarm. The simplicity of operation of the AED has greatly reduced training requirements and extended the range of people who are able to provide defibrillation. As a result, AEDs can be more widely deployed in public places. One of the greatest challenges in designing the AED is the design of its digital signal processing (DSP) algorithm. DSP is considered as the brain of AED as it has to decide on its own whether the rhythm is shockable or not; therefore, it is of vital importance that the ECG analysis algorithms used by AEDs differentiate well between shockable and non-shockable rhythms. AED should not deliver a shock if the patient has collapsed due to a reason other than cardiac arrest; on the other hand, a successfully defibrillated patient should not be defibrillated again due to an analysis error, which would possibly bring the subject back into cardiac arrest.

AED operation guideline

Since most of the operation is automated and performed by the device, operators only need few or no medicine knowledge, making possible its use by virtually anybody.

An AED only has a pair of electrodes to be correctly placed on the patient (Figure 1.4), and this is the only difficulty of use. Once the electrodes are placed the AED automatically perform ECG analysis on the patient to evaluate the necessity of defibrillation. In positive cases the AED notify the operator that defibrillation is indeed required, and wait for him/her to push the “defibrillation” button. The defibrillation release is left to the operator, in order to avoid possible hazardous situations -e.g. the operator should not touch the patient during defibrillation.

The relative ease of use, coupled with a capillary diffusion of AED could significantly rise the chances of surviving a Sudden Cardiac Arrest.

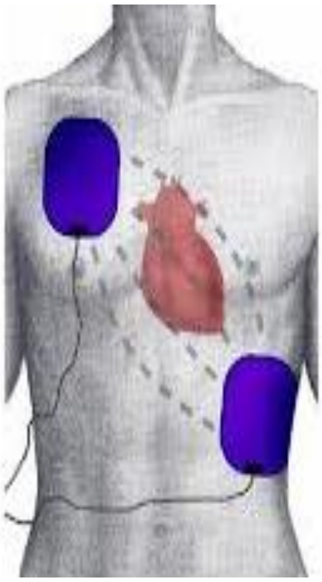

Figure 1.4: Placement of electrodes for defibrillation

CHAPTER 2

LITERATURE SURVEY

There are a number of VF detection algorithms in the literature. These algorithms use different mathematical methods and transformations to extract certain features of a signal. The VF detection methods can be mainly categorized into three groups:

Time domain: Time domain analysis requires less computational time, since there is no transformation of the signal into the frequency domain. Examples include Threshold Crossing Intervals Algorithm (TCI) in which decisions are based on the number and position of signal crossings through a certain threshold, Autocorrelation Algorithm which distinguishes between periodic (normal sine rhythm) and non-periodic (VF) signals, and Tompkins algorithm which uses slope, amplitude and width of the QRS information as a feature to perform the classification.

Frequency domain: The signal is transformed into the frequency domain by means of Fourier transform. The main advantage of this method is that certain frequency noise such as high frequency noise can be easily removed. In addition, frequency dependent features of SR or VF can be easily treated in this domain. Examples include Spectral Filters and Spectral Algorithms which analyse the energy content of different frequency bands.

Combined methods: Example of this method which makes use of both time and frequency domain analysis is wavelet based algorithms. The computational complexity of these algorithms might be higher than the techniques mentioned above. In the following sections some of the VF detection algorithms are explained in details.

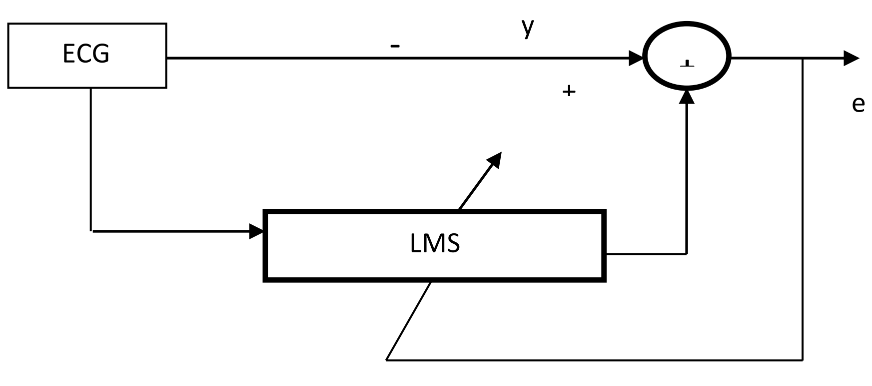

Figure 2.1: Schematic of adaptive filter

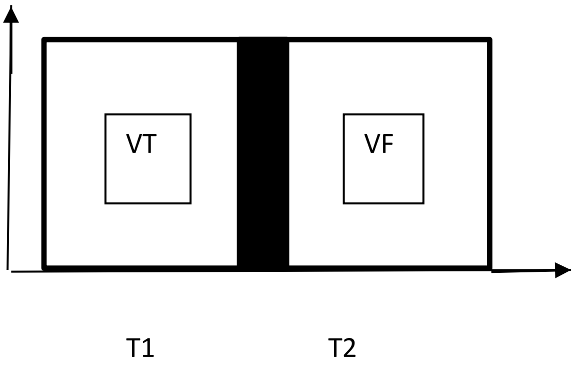

Figure 2.2: Distribution of EE

Ventricular Fibrillation Detection By Adaptive Algorithm

Ventricular Fibrillation detection by adaptive algorithm is a relatively simple and accurate method for discriminating VF from VT using a Least Mean Square (LMS) algorithm. In the first stage of the algorithm the ECG signal is fed into the LMS filter and the energy of the error signal (EE) is calculated.

The second stage is the learning period in which the detection thresholds of VF and VT are determined. The threshold can be determined from the energy of the error signal. The EE is larger for the signals with greater power and worse autocorrelation. Since the autocorrelation of VT is better than that of VF and the average power of VF is greater than that of VT it can be concluded that the EE of VF is greater than that of VT. Figure 2.2 shows the distribution of VF and VT energy error. Thus, in learning phase thresholds T1 and T2 are obtained and the ECG signals with EE smaller than T1 can be considered VT and that larger than T2 VF. No decision will be made if EE is in the shadowing area. In this case sequential test is applied in which another segment of ECG signal is inputted to the LMS algorithm and EE is calculated until a decision is made.

Ventricular Fibrillation Detection Using Pseudo Wigner Ville Distribution

Rosado et al. presented a real time VF detection algorithm that combines both time domain and time-frequency domain parameters which results in lower computational calculations. Time domain parameters are used as an initial stage of the VF detection algorithm due to its good behaviour in non-VF rhythms rejection. Discarding segments that are clearly different from VF results in increase in specificity and avoids the calculation of time-frequency distribution in such cases. In VF episodes prominent QRS peaks are inexistent; therefore, squaring the ECG time series x(t) (obtaining x(t)') results in increase of peaks, and dividing x(t)' by its mean, results in unit mean. The variance value, for x(t)' is closely related to QRS peak presence; a high value is considered as no VF.

The second time domain parameter is called RatioSTD which is the quotient between the standard deviation of the derivative and the standard deviation of the absolute value of the derivative for the ECG time series. This parameter gives an idea about the symmetry between positive and negative values. In the case of normal Sine rhythm no symmetry exists. On the other hand, in the case of VF, due to oscillating nature of the VF signal higher values of RatioSTD are obtained.

$$VF = \frac{1}{N}[\frac{X'}{\mu\left(X'(t)\right)} - 1]^2 = \sigma(\frac{x'}{\mu\left(X'(t)\right)})$$

Hilbert Transform

Aman et al. proposed a method that differentiates SR from VF based on phase-space plots .This method is based on a method which is used in analysing nonlinear signals. Hilbert transform is defined using the Cauchy principal value (denoted p. v.) and is given by:

$$X_H(t) = \frac{1}{\pi}\ P.V \int \frac{x(\tau)}{t - \tau} d\tau$$

Hilbert transform can be considered as the convolution of the functions x (t) and 1/(pi)t. Due to the properties of convolution it can be concluded that the Hilbert transform can be realized by an ideal filter whose amplitude response is unity and phase response is a 90 degrees time shift at all frequencies w> 0. In the phase-space plot the signal is plotted on the x-axis, and the Hilbert transform of the signal, Xn(t) is plotted on they-axis (Figure 2.4). A 40 x 40 grid is produced and the number of boxes visited by the ECG signal is counted and the measure d is calculated: d = (visited boxes) / (number of all boxes).

If d is higher than a certain threshold, the corresponding ECG segment will be classified as VF. In the threshold was chosen to be 0.15.

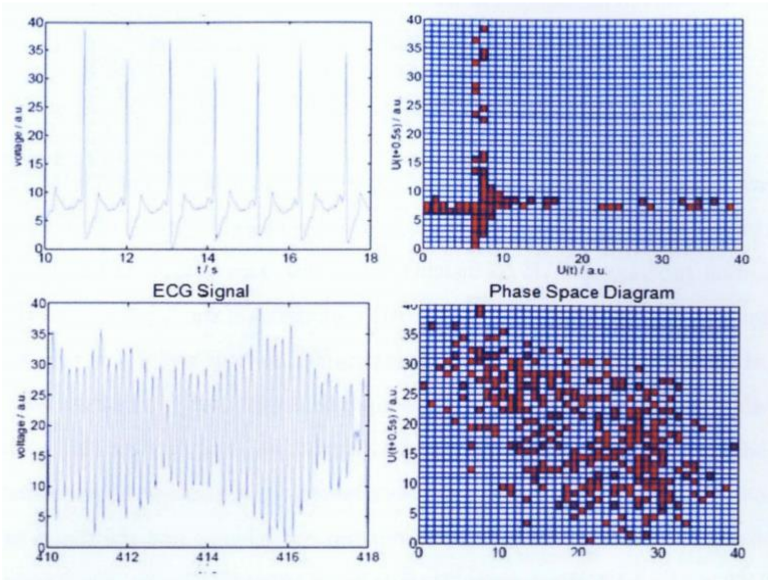

Figure 2.3: ECG signals (left) and their corresponding phase-space plots (right)

Generalized Linear Method

Krishnan et al. used Generalized Linear Method (GLM) based classification model to distinguish VF from SR. GLM is a statistical linear model and is given by:

$$\hat{Y} = A\beta + \epsilon$$

where Y^ is an N dimensional vector of observed responses, Beta is the unknown least square estimator, and A is a N (P + 1) matrix of known AR coefficients. During the first phase of the classification, the classifier needs to be trained using the known classes of ECG signals. In this phase, the auto regressive coefficients are calculated for each signal in the training 17 set, and the observed signals (Y^) is set to 1 for normal SR signals in the training set and -1 for VF. The least square estimator can then be computed from:

$$\beta = (A^T A)^{-1} A^T \hat{Y}$$

The least square estimator is calculated only once from the training samples (from the known classes of ECG). After the training phase, the classification can be performed. In the classification process, the AR coefficients of the test data (ECG segment to be analysed) are obtained. If the multiplication of the AR coefficients of the test data and the previously obtained estimator is positive, the signal is classified as NSR and if it is negative the signal is classified as VF. In this project Burgs algorithm was used to compute AR coefficients. AR model becomes less sensitive to model order P, for P more than three. However, the AR model of order four was selected for extracting the features. The criteria for selecting the model order are the correlation coefficient (rho) and the signal to noise ratio (SNR). The (rho) and SNR are given by equations below.

$$\rho = \frac{\sum_{1}^{i=N}(v(i) - m)(\tilde{v}(i) - \widetilde{m})}{\sqrt{\sum_{1}^{i=N}(v(i) - m)^2 \sum_{1}^{i=N}(\tilde{v}(i) - \widetilde{m})^2}}$$

$$SNR = 10log \frac{\sum_{1}^{i=n}(v(i))^2}{\sum_{1}^{i=N}(v(i) - \tilde{v}(i))^2}$$

where v(i) and v~(i) are the original and the simulated signals, and m and mare the mean of the original and simulated signals respectively.

In the paper basically speaks about the importance of Automated External Defibrillators as an immediate clinical assistance for SCA patients. The most effective way to treat a SCA is with defibrillation, namely a therapeutic dose of electrical energy. The necessity of performing defibrillation within a few minutes of SCA has led to the development of AEDs: their timely use can improve outcome after SCA. For this reason, AEDs have been designed to be used with little or no medical knowledge allowing the widespread distribution of these devices for reducing SCA victims. AEDs should be present in public places with the highest probability to have SCA events, such as public transportation areas (train stations or airports), shopping malls, schools and colleges, working areas etc.

In paper [2], untrained laypersons can use semi-automated AEDs sufficiently quickly and with minimal instructions. The observation that measures of practical performance (i.e. time to first shock, accuracy of electrode pad placement and safety) were significantly improved after minimal theoretical instruction, but without technical instruction in the use of the device. One of the most remarkable findings is that all tested laypersons were able to deliver a shock in less than 1 min after minimal instructions had been given, regardless of whether automatic or semiautomatic mode was used. Finally, the paper concludes that only minimal background knowledge is needed for laypersons to use an AED safely and quickly, and that further implementation of AEDs for use by minimally trained persons without any medical training is possible.

In paper [3], Use of automated external defibrillators (AEDs) by first arriving emergency medical technicians (EMTs) is advocated to improve the outcome for out-of-hospital ventricular fibrillation (VF).

In paper [4], in order to make the actual energy of defibrillation approximate to target defibrillation energy in automated external defibrillator, aa energy compensation method is used. This is undoubtedly a real blessing for medical instruments, in pursuit of safety and stability. The research on energy compensation of defibrillators has made a considerable achievement, but energy compensation still has big space for improvement, and further research needs to be continued.

In paper [5], the paper presents a novel compositive algorithm by merging a slope variability analyzer with a band-pass digital filter to accurately distinguish shockable rhythms from non-shockable rhythms for automatic external defibrillators.

CHAPTER 3

PROBLEM IDENTIFICATION

FORMULATION

- Pressing on the chest can cause a sore chest, broken ribs or a collapsed lung. CPR may not be able to restart your heart. Hence we go for defibrillators.
- In India, the only available defibrillators are under doctor supervision and cannot be operated by a layman.
- The cost of Importing External Defibrillator (due to unavailability in INDIA) is around $1500-$2000, while the manufacturing cost (in bulk) is approximately $500 per kit.
- Existing defibrillators use software technologies which use lengthy algorithm codes for detection of SCA.

CHAPTER 4

OBJECTIVES

An AED, or automated external defibrillator, is used to help those experiencing sudden cardiac arrest. It's a sophisticated, yet easy-to-use, medical device that can analyse the heart's rhythm and, if necessary, deliver an electrical shock, or defibrillation, to help the heart re-establish an effective rhythm.

Most SCAs result from ventricular fibrillation (VF). VF is a rapid and unsynchronized heart rhythm that originates in the heart’s lower chambers (the ventricles). The heart must be “defibrillated” quickly, because a victim’s chance of surviving drops by seven to 10 percent for every minute a normal heartbeat isn’t restored.

The main objective of this project is as follows:

- **To reduce deaths due to sudden cardiac arrest:**Sudden cardiac deaths are sudden, unexpected(with no symptoms) death caused by the loss of heart function. Sudden cardiac death occurs most frequently in adults in their mid-30s to mid-40s, and affects men twice as often as it does women. This condition is rare in children, affecting only 1 to 2 per 100,000 children each year. When this occurs, the heart is unable to pump blood and death will occur within minutes, if left untreated. **Emergency treatment** includes cardiopulmonary resuscitation (CPR) and Defibrillation: the stopping of fibrillation of the heart by administering a controlled electric shock, to allow restoration of the normal rhythm.
- **To implement cost effective DEFIBRILLATORS:** The cost of Importing External Defibrillator (due to unavailability in INDIA) is around $1500-$2000, while the manufacturing cost (in bulk) is approximately $500 per kit. Hence we go for cost effective defibrillators.
- **To make AEDs easily accessible to common citizens at public places:** In India, the only available defibrillators are under doctor supervision, therefore we have to make sure the AEDs are accessed byNon-medical personnel such as police, fire service

personnel, flight attendants, security guards and other lay rescuers with the help of visual and voice prompts at public places.

CHAPTER 5

METHODOLOGY

A defibrillator is a mechanism that sends the heart through a high-energy electric shock. A high-energy shock is called defibrillation. The aim of this shock is to restore a heart to its usual state of operation if it goes into cardiac arrest.

When a patient shows symptoms of a cardiac arrest, a defibrillator may be used to bring their heart back to its usual rhythm. A cardiac arrest occurs when the heart abruptly stops pumping blood throughout the body, usually due to an electrical signalling malfunction in the heart. If the heart stops pumping blood through the body, the brain is needy for oxygen and can even cause a person to lose consciousness and stop breathing.

The most sudden cardiac deaths occur from irregular heart rhythms called arrhythmias. Ventricular fibrillation is the most severe life-threatening arrhythmia which is an uncontrolled, uncoordinated firing of ventricular impulses (the lower chambers of the heart). When this takes place the heart is unable to pump blood, and if left untreated, death will result within minutes.

A cardiac arrest is considered a serious medical emergency and care needs to be taken immediately, or it may be dangerous. When a person experiences cardiac arrest, they will be unconscious, inoperable and therefore they do not breathe or they do not breathe normally. In such cases emergency treatment includes Cardiopulmonary Resuscitation (CPR) and defibrillation. Pressing on the chest can cause a sore chest, broken ribs or a collapsed lung. CPR may not be able to restart your heart. Hence, we go for defibrillators.

The flowchart below describes the mechanism of Defibrillation:

We should use a defibrillator if you are resuscitating an unconscious person with the help of others. You can then share the different tasks: One person can start doing chest compressions, while the other person (or people) call for an ambulance and get the defibrillator.If you are alone, call for an ambulance first and then immediately start doing chest compressions.As soon as you get hold of a defibrillator, you have to turn it on and connect it. It's important to continue doing chest compressions until the device tells you to stop. Work together: One person can do chest compressions, while another person sticks the two electrodes on the naked chest of the unconscious person.

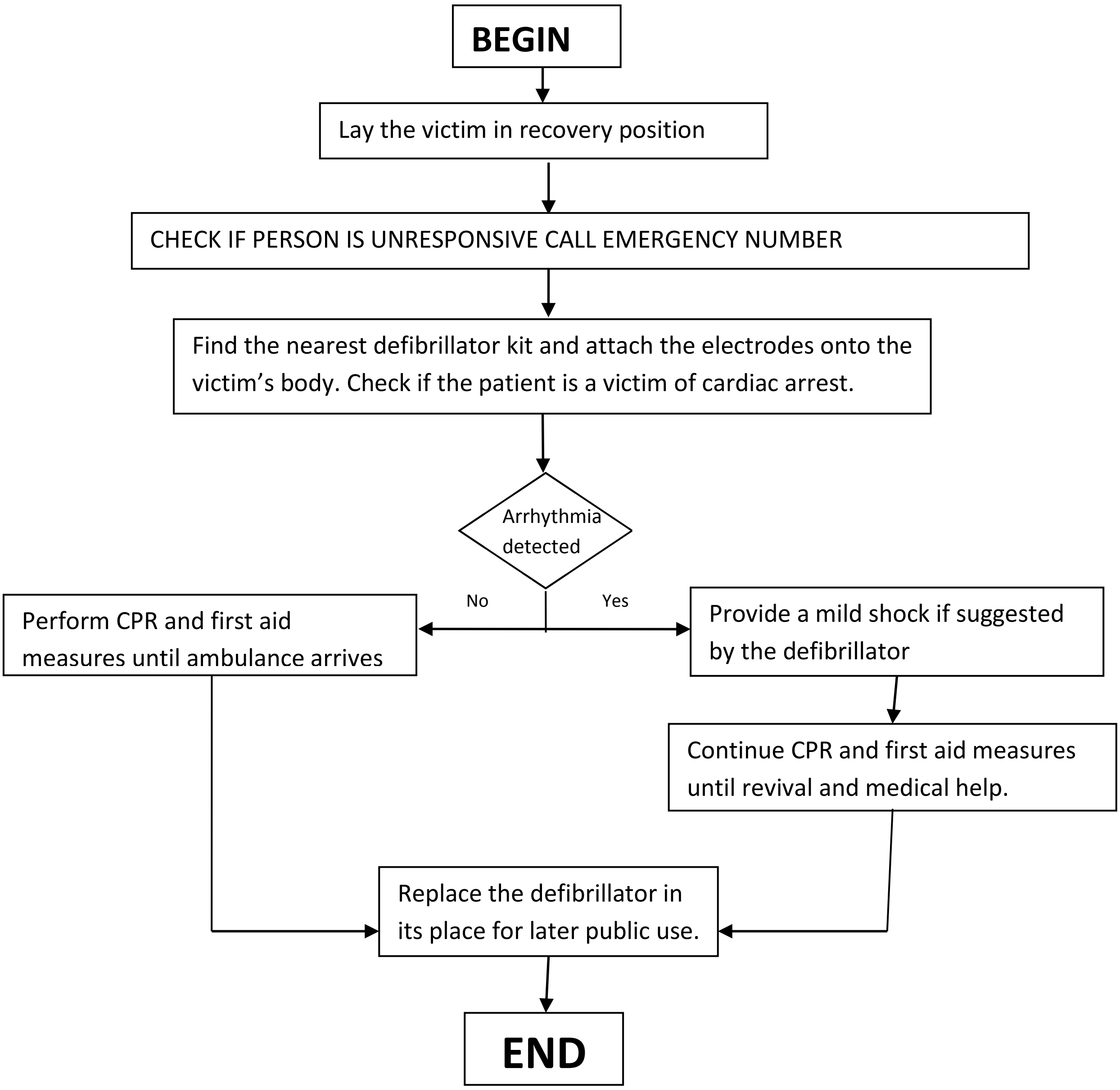

Figure 5.1. Flowchart of Mechanism of Defibrillation

One of the electrodes should be placed under the right collarbone, and the other should be placed on the left side of the chest – under the armpit. Then follow instructions given by the device.

If the defibrillator recognizes that someone's heart is fibrillating, it will ask you to press the shock button to produce an electric shock. Follow the instructions given by the device. Continue to follow the instructions given by the defibrillator afterwards – for instance, the device may tell you to do chest compressions again.

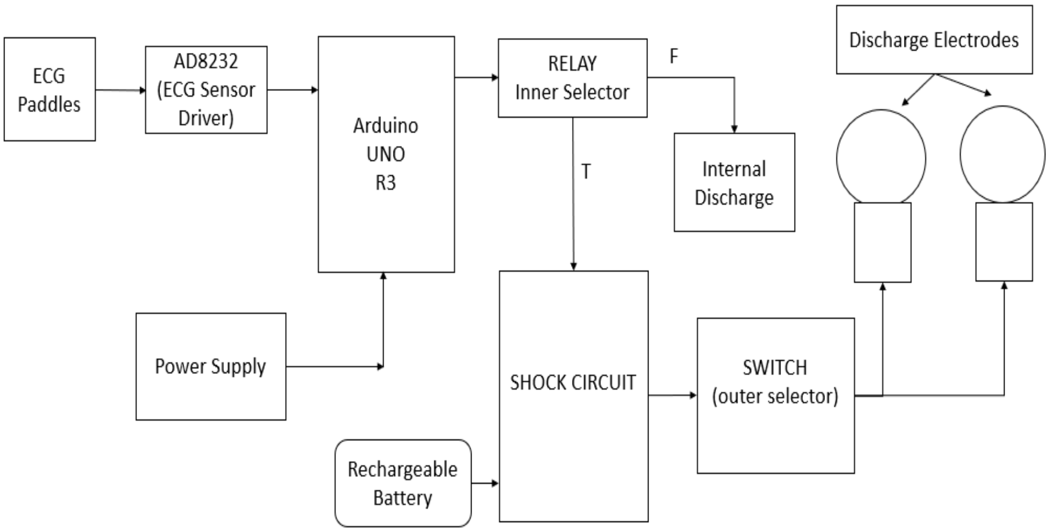

Figure 5.2. Block Diagram of Semi-automated defibrillator.

The block diagram of semi-automated external defibrillator consists of the above blocks as shown in the figure 3.2. Power supply module comprises of the battery and the voltage regulators. The controls are handled by the controller and some input output components such as switches and LED diodes. The charging circuit, the capacitors are used to generate the high voltages for providing shock. The inner selector circuit comprises of relays which are used as selectors and an internal discharge circuit composed of a power resistor.

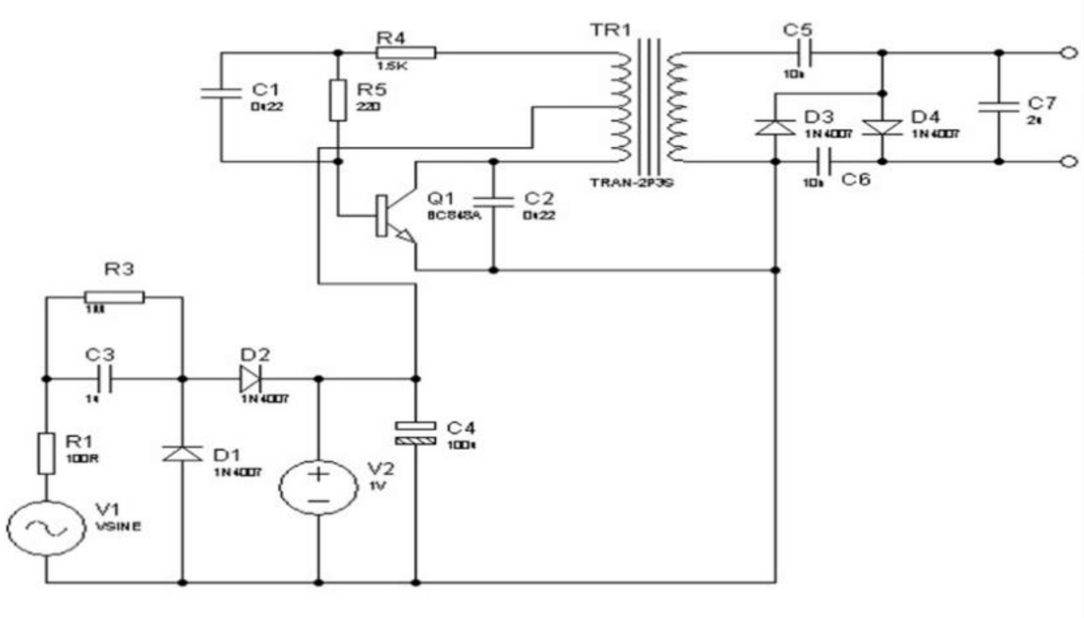

Figure 5.3 Defibrillation circuit.

Referring to the figure above we see that the circuit is basically made up of three stages viz. the power supply stage, the oscillator stage and the voltage booster stage.

- **Power supply stage**:

This part consists of three components the Transformer, the Bridge Rectifier, and the Filter Capacitor. The Transformer is used to step down the applied AC mains through electromagnetic induction. But this voltage is still a low voltage AC and requires rectification and filtration. Rectification is done by the bridge rectifier (comprised of 4 rectifier diodes) and this rectified voltage is further filtered by the preceding electrolytic filter capacitor to produce a clean DC at the output.

To operate with 3V DC supply, the winding inside the coil is determined, meaning that the circuit is made compatible with a 3V battery pack made by placing a few cells into series.

The transistor and the center tapped transformer immediately start oscillating at the specified high frequency, when power is applied to the circuit. It forces the battery current to travel in a push pull way through the TR1 winding. Switching operation produces a proportional high voltage generated by the secondary TR1 winding, this voltage generated is somewhere around 200V.

- **Oscillator stage:**

The oscillator stage mainly consists of an oscillator which helps in conversion of DC input applied as shown in the circuit(Fig.3) to an oscillating current or a square wave fed to the secondary winding of a power transformer. In the present circuit Blocking oscillator circuit concept is used, A blocking oscillator is one of the simplest form of oscillators which is able to produce self-sustaining oscillations through the use of just a few passive and a single active component. The name "blocking" is applied due to fact that the switching of the main device in the form of a BJT is blocked (cut-of) more often than it's allowed to conduct during the course of the oscillations, and hence the name blocking oscillator. R1 along with the pre-set and the C1 determine the frequency of oscillation. R1 ensures that the transistor never comes within an unsafe zone while adjusting the pre-set.

- **Voltage booster stage:**

In this stage further enhance and lift this voltage to a level which may become suitable for generating a spark, a charge pump circuit involving a Crockcroft-Walten ladder network is used at the output of TR1.This network pulls the 200V from the transformer to about 600V.This high voltage is rectified and applied across a bridge rectifier where it is completely rectified and it is stepped up by the 2uF/1KV capacitor.

As long as the output terminals are kept at a specified distance around the 2uF capacitor, the high-voltage energy stored within the condenser cannot be discharged and remains in a standby state.

When the terminals are bought at a comparatively closer distance (about a few mms), the potential energy through the 2uF capacitor is theoretically capable of breaching the air barrier to arc through the terminal gap in the form of a flying spark.

Once this happens, the arcing stops momentarily, until the capacitor fully charges to execute another spark, and the cycle continues to repeat as long as the gap is kept within the saturable distance of the high voltage.

The circuit also contains a small charging circuit which can be connected to the mains to charge the rechargeable 3V battery when the battery stops producing enough arcing voltage when giving shock.

The Semi-automated external defibrillator is programmed with custom firmware in C programming language. The firmware acts as a finite-state machine, in which each state is used to enable or disable specific circuits depending on the state itself. The five different states are presented in the below figure and their operations are:

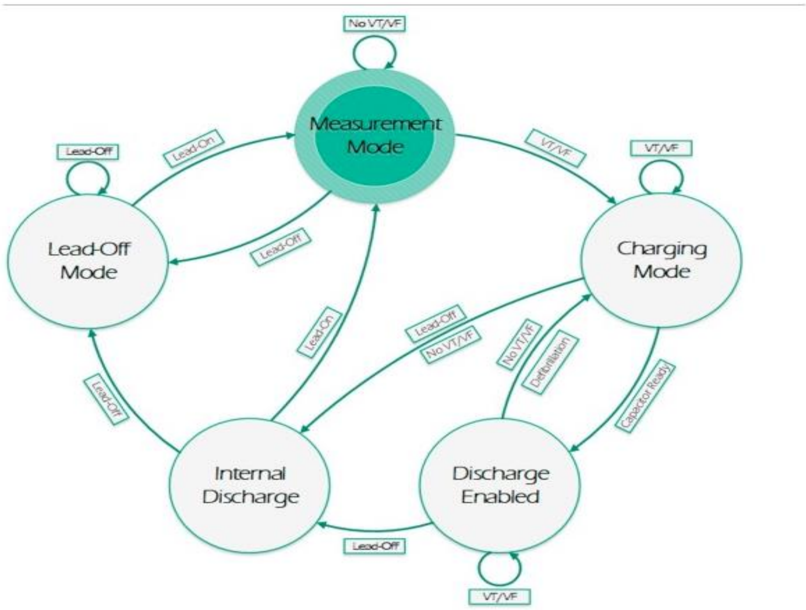

Figure 5.4 Finite State machine diagram for S-AED

•*Measurement mode* is the starting state. In measurement mode, the device has not yet diagnosed SCA in the patient. Therefore, the operations are limited to continuously acquiring ECG and impedance signals from the patient.

•*Charging mode* state is reached when OAED successfully diagnoses SCA for the first time. As a result, the charging circuit is enabled, while the patient is still monitored for SCA.

•*Discharge enabled mode* is entered when the patient is both suffering from SCA and the capacitor is ready. In this mode the defibrillator is armed and ready to deliver the shock when the operator will press the "*defibrillate"* button.

•*Internal discharge mode* represents an emergency stop for OAED. Whenever something is not working properly and the capacitor is charged (even partially), OAED will dump the defibrillation energy to the *internal discharge circuit*, which is a power resistor.

•*Lead-Off mode* is an idle state in which OAED just waits for a patient to be connected. Thereafter in this state, OAED will only perform impedance acquisitions. When it recognizes a patient, lead-off mode is switched to Measurement mode.

- **MEASUREMENT MODE:** This state is by default the initial state. When entering *measurement mode* the device start ECG acquisitions and continuously check if the electrodes are still on the patient. If it cannot detect them then the "lead detected" flag is set to false, then the status is changed to *lead-off mode*. On the other hand if it is true, OAED check if there is new data pending ready to be analysed. In the positive case, it runs the pattern recognition algorithms on the ECG to diagnose SCA. If this is also positive, the system state is changed to *charging mode*. Otherwise it wait for new data to be available. When this happen it stops the acquisition, overwrite the data array with the buffer, and finally it restart the *measurement mode*. While idling waiting for new data, the device keep checking whether the electrodes are still on the patient. In the negative case, it immediately enters *lead-off mode*.

- **CHARGING MODE:**The *charging mode* is entered as soon as OAED detects the first SCA event, and it represent an "alert" mode. In fact, while in this state the device en-able the capacitor charging circuit (see chapter 3), and continue checking the patient status. The flow-chart in this mode (represented in Figure 5.4) is similar to the last (Figure 5.3). In addition to what said above, after it evaluate the ECG, OAED checks whether the capacitor is charged. If it is ready and the patient is still suffering SCA, then the device pass in *discharge enabled mode*. Otherwise the following may happen: whenever the "lead detected" flag become false; the device automatically pass in *internal discharge mode*; if OAED cannot assert SCA on the patient any more, the device will remain this state until either: SCA is diagnosed again, or it reaches the maximum limit of false positive event (set to five by default). In the latter case, state is changed to *internal discharge mode*. if the capacitor is not ready yet, but there is new data, OAED stops acquisition, overwrites ECG data array with its buffer, and finally it restarts the *charging mode*.

- **DISCHARGE ENABLED MODE:** This state represent the operative mode. OAED can only enter *discharge enabled mode* when SCA is definitely diagnosed and the capacitor is ready to release a defibrillation. While in this mode OAED enable the interrupt triggered by the defibrillation push-button (see chapter 4), allowing the operator to deliver a defibrillation to the patient at any time. When this happen, the device will return in *charging mode*. As we can see from the flow-chart in Figure 5.5, this state is extremely similar to the measurement mode. In fact, if we do not consider the charging circuit and the defibrillation push-button, the system working is analogous. OAED start the acquisition and check if the electrodes are still placed on the patient. Then it wait for new data, analyse it, and stops the acquisition to restart the *discharge enabled mode*. The main difference are: if OAED detect a lead-off, it pass to *internal discharge mode* instead of *lead-off mode*; and if the ECG pattern recognition fail to diagnose SCA, the device return in *charging mode*.

  Defibrillation

  In OAED various function that perform the defibrillation were implemented. All these functions control the H-Bridge circuit dynamically calculating the time required for each phase, depending on the patient impedance.

- **LEAD OFF MODE:** The *lead-off mode* (see Figure 5.6) represent a safety condition for the de- vice. In fact, this state is only entered when OAED cannot detect a patient, and it will not exit until it can. When OAED enter the *lead-off mode*, it will:

1. stop ECG acquisition since is no longer needed;
2. reset event counter, buffers, and data arrays. Since we can't know if OAED will be reconnected to the same person, we must restart the diagnose process from the beginning;
3. wait until it can detect a patient again. If a patient is detected, OAED will transit to *measurement mode* and treat him/her like a new patient. We don't have any mean to understand if is connected to the same person, therefore we must restart the diagnose from zero in order to be sure of avoiding to defibrillate a sane person.

- **INTERNAL DISCHARGE MODE:** The *internal discharge mode* is more a transition-state, than a proper state. This mode represent an emergency stop for the device. In fact, *internal dis- charge mode* is entered from *charging mode* or *discharge enabled mode* when OAED detects a lead-off, or a false positive case of SCA. While in this state, OAED release the capacitor charge in the internal discharge circuit (see chapter 3), and then move either in *lead-off mode*, or *measurement mode*, depending on the electrodes status. An alternative to prioritize energy saving could be to enter this state only when actually needed. E.g. in the case of malfunctioning, or before the device shut-down.

CHAPTER 6

HARDWARE AND SOFTWARE DESCRIPTION

6.1 HARDWARE USED:

6.1.1 ARDUINO UNO R3 BOARD:

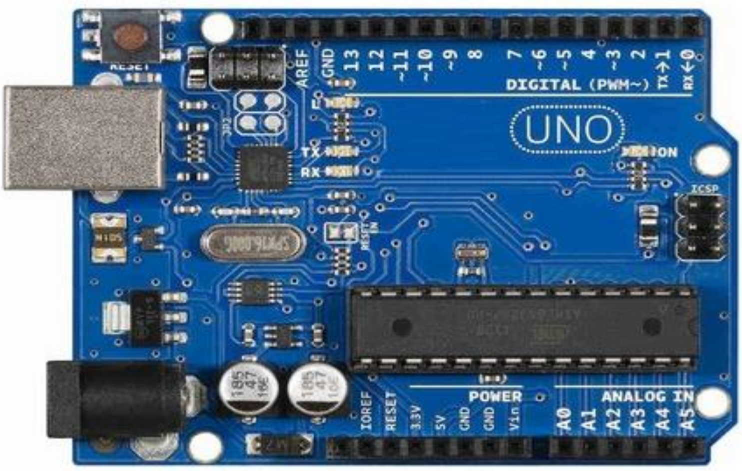

Figure 6.1 Arduino UNO R3 Board.

The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE(Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

6.1.2 AD8232 ECG SENSOR KIT:

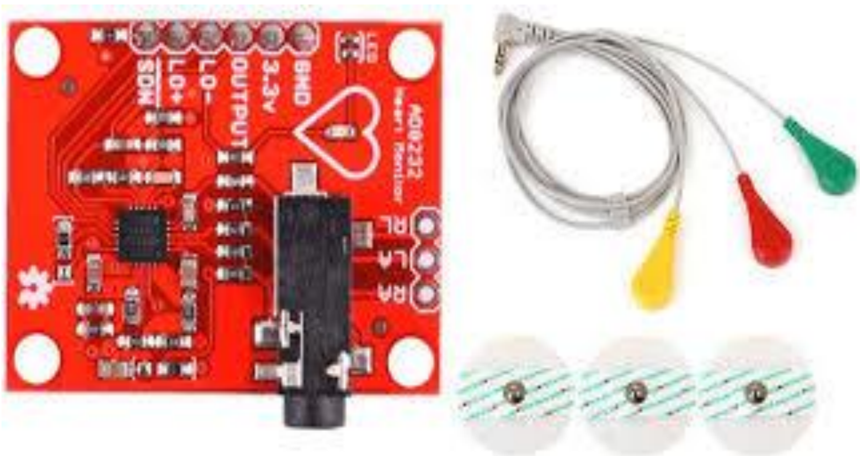

Figure 6.2 AD8232 ECG Sensor along with Electric paddles

The AD8232 Single Lead Heart Rate Monitor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal from the PR and QT Intervals easily.

The AD8232 is an integrated signal conditioning block for ECG and other bio potential measurement applications. It is designed to extract, amplify, and filter small bio potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultra-low power analog-to-digital converter (ADC) or an embedded microcontroller to acquire the output signal easily.

The AD8232 Heart Rate Monitor breaks out nine connections from the IC that you can solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with an Arduino or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors. Additionally, there is an LED indicator light that will pulsate to the rhythm of a heartbeat.

6.1.3 OTHER COMPONENTS:

The other components includes Rechargeable battery(3V), Transformer – step up and step down, transistors, capacitors, resistors, diodes, relays which acts as selectors, connecting wires, Electrodes etc. The specifications of each and every components are given in the below circuit diagram.

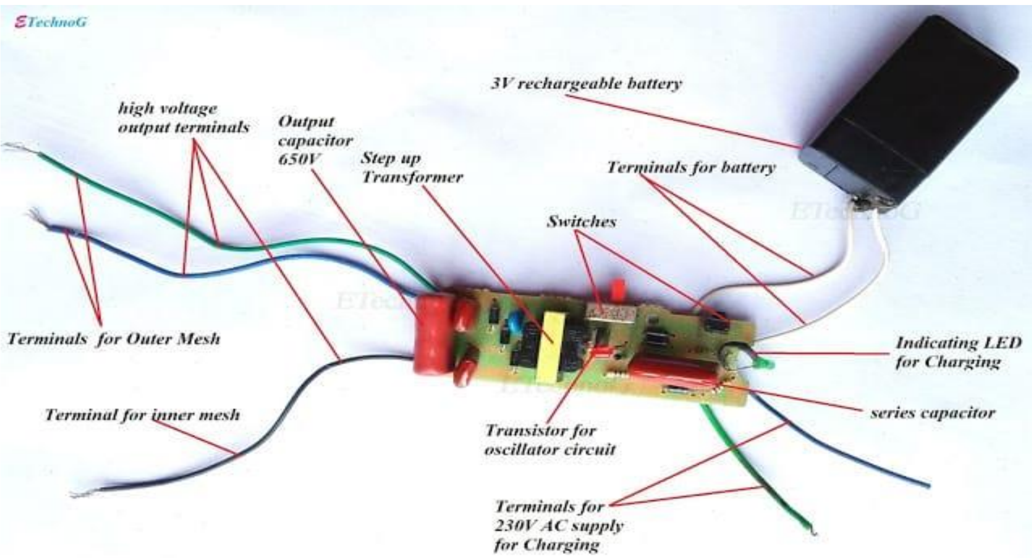

figure 6.3 Components in defibrillator circuit.

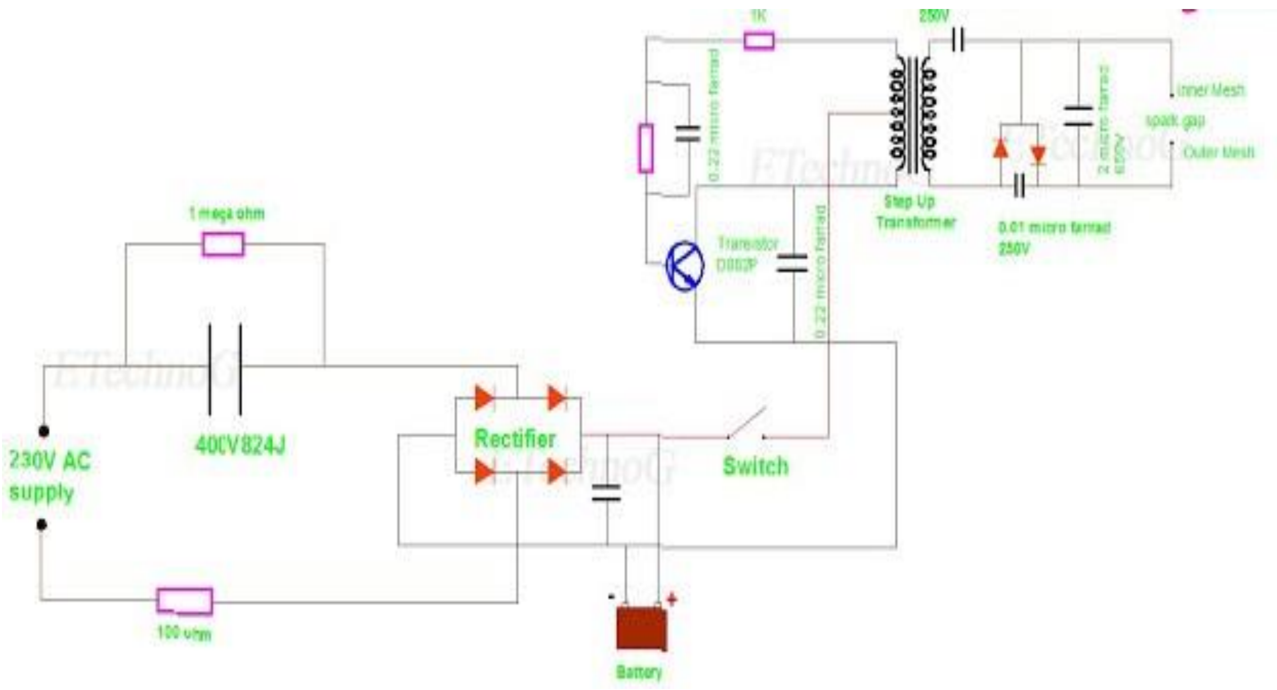

Figure 6.4. Defibrillator circuit.

Transformer less power supply:

As you see in the above the circuit diagram it has Transformer less Power supply system for charging the battery(3V rechargeable battery).

Oscillator Circuit:

As we already know that battery has DC source and we cannot step up DC. So an Oscillator circuit is used to convert DC to Pulsating AC. The Oscillator circuit consists of a Transistor, capacitors, and resistors.

Transformer:

Transformer used here is a pulse transformer is used to step up the oscillating frequency and voltage.

Ladder Network:

The output of the transformer is boosted up through a ladder network which consists of diodes and capacitors.

Output Capacitor:

In this, circuit has a non-polarized capacitor of 650V which connected in parallel with the output terminals for storing high voltage and discharge during operation.

6.2 SOFTWARE USED:

6.2.1 ARDUINO SOFTWARE IDE:

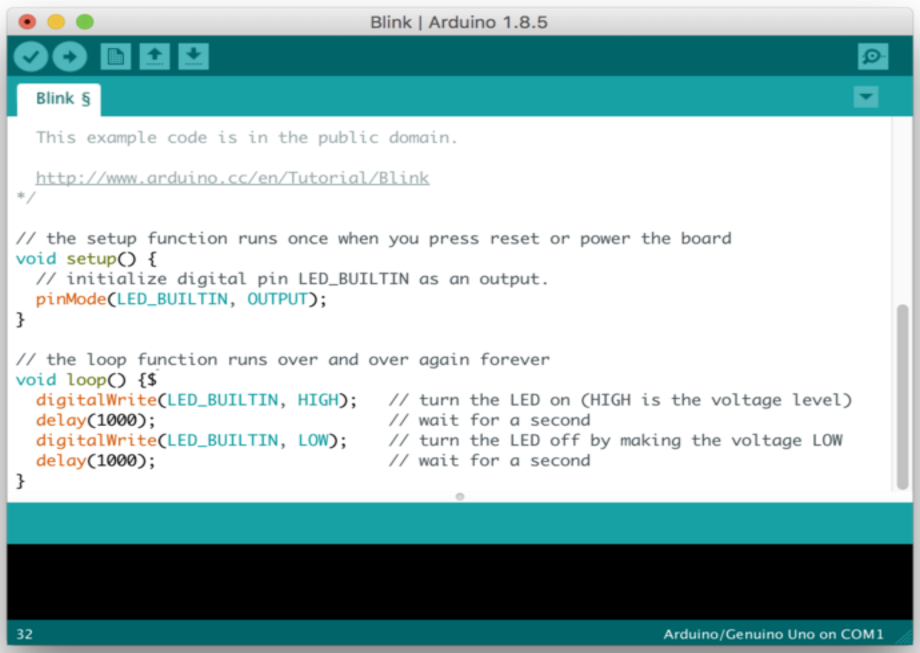

Figure 6.5 Arduino Software IDE

The **Arduino Integrated Development Environment (IDE)** is a cross-platform application (for Windows, macOS, Linux) that is written in functions from Cand C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages Cand C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution.The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers.

The Arduino ecosystem is comprised of a diverse combination of hardware and software. The versatility of Arduino and its simple interface makes it a leading choice for a wide range of users around the world from hobbyists, designers, and artists to product prototypes.

The Arduino board is connected to a computer via USB, where it connects with the Arduino development environment (IDE). The user writes the Arduino code in the IDE, and then uploads it to the microcontroller which executes the code, interacting with inputs and outputs such as sensors, motors, and lights.

Both beginners and experts have access to a wealth of free resources and materials to support them. Users can look up information on how to set up their board or even how to code on Arduino. The open source behind Arduino has made it particularly friendly to new and experienced users. There are thousands of Arduino code examples available online. In this post, we'll take you through some basic principles of coding for Arduino.

6.2.2 PROGRAMMING IN ARDUINO:

Arduino programs are written in the Arduino Integrated Development Environment (IDE). Arduino IDE is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino boards. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution.

The first step in programming the Arduino board is downloading and installing the Arduino IDE. The open source Arduino IDE runs on Windows, Mac OS X, and Linux. Download the Arduino software (depending on your OS) from the official website and follow the instructions to install.

There is a lot to be said of Arduino's software capabilities, but it's important to remember that the platform is comprised of both software and hardware. The two work in tandem to run a complex operating system.Code → Compile → Upload → RunAt the core of Arduino, is the ability to compile and run the code.After writing the code in the IDE you need to upload it to the Arduino. Clicking the Upload button (the right-facing arrow icon), will compile the code and upload it if it passed compilation. Once your upload is complete, the program will start running automatically.

Arduino code is written in C++ with an addition of special methods and functions, which we'll mention later on. C++ is a human-readable programming language. When you create a 'sketch' (the name given to Arduino code files), it is processed and compiled to machine language.

The Arduino Integrated Development Environment (IDE) is the main text editing program used for Arduino programming. It is where you'll be typing up your code before uploading it to the board you want to program. Arduino code is referred to as

Unlike other software programming platforms, Arduino doesn't have an onboard debugger. Users can either use third-party software, or they can utilize the serial monitor to print Arduino's active processes for monitoring and debugging.

In Arduino, much like other leading programming platforms, there are built-in libraries that provide basic functionality. In addition, it's possible to import other libraries and expand the Arduino board capabilities and features. These libraries are roughly divided into libraries that interact with a specific component or those that implement new functions.

The basic Arduino code logic is an "if-then" structure and can be divided into 4 blocks:

Setup - will usually be written in the setup section of the Arduino code, and performs things that need to be done only once, such as sensor calibration.

Input - at the beginning of the loop, read the inputs. These values will be used as conditions ("if") such as the ambient light reading from an LDR using analog Read().

Manipulate Data - this section is used to transform the data into a more convenient form or perform calculations. For instance, the Analog Read () gives a reading of 0-1023 which can be mapped to a range of 0-255 to be used for PWM (see analog Write())

Output - this section defines the final outcome of the logic ("then") according to the data calculated in the previous step. Looking at our example of the LDR and PWM, turn on an LED only when the ambient light level goes below a certain threshold.

6.2.3 PHYSIONET

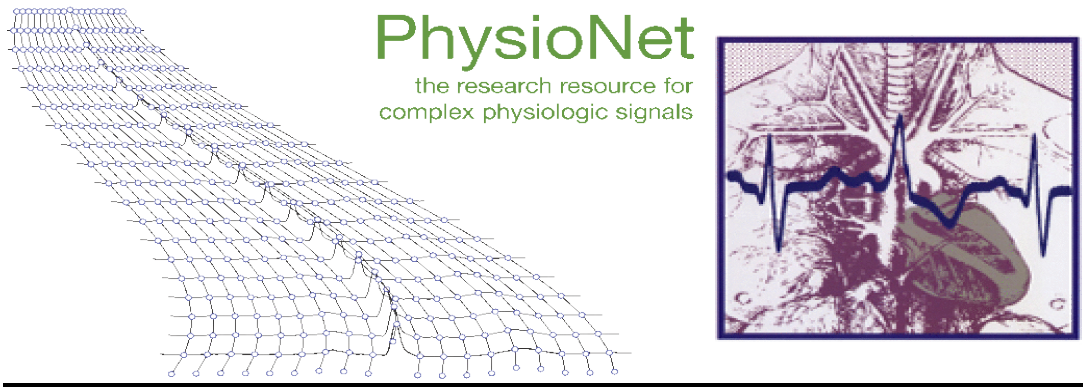

Figure 6.6 Physionet

Physio Net offers free web access to large collections of recorded physiologic signals (Physio Bank) and related open-source software (Physio Toolkit). Physio Bank databases are made available under the ODC Public Domain Dedication and License v1.0. Physio Bank is a massive archive of physiological data. It contains over 90,000 recordings, or over 4 terabytes of digitized physiologic signals and time series, organized in over 80 databases.

In this context, a database is simply a collection of recordings (records), available as a set of flat files. In contrast to typical relational databases, Physio Bank databases consist of relatively small numbers (tens to thousands) of records that may each be quite large (in some Physio Bank databases, the size of a record can be a gigabyte or more, although typical record sizes are a few Mb).

Each database consists of a set of records, identified by the record name. In most cases, a record consists of at least three files, which are named using the record name followed by distinct suffixes that indicate their contents. For example, the MIT-BIH Arrhythmia Database includes record 100; the three files 100.atr, 100.dat, and 100.hea together comprise record 100. Al- most all records include a binary .dat (signal) file, containing digitized samples of one or more signals; these files can be very large. The .hea (header) file is a short text file that describes the signals (including the name or URL of the signal file, storage format, number and type of signals, sampling frequency, calibration data, digitizer characteristics, record duration and starting time). Most records include one or more binary annotation files (in the example, .atr denotes an annotation file). Annotation files contain sets of la- bels, each of which describes a feature of one or more signals at a specified time in the record; 100.atr, for example, contains an annotation for each QRS complex in the recording, indicating its location and type (normal, ventricular ectopic, etc.), as well as other annotations that indicate changes in the predominant cardiac rhythm and in the signal quality. In other databases, annotations mark other features of the signals. In addition to the data, PhysioBank integrates a series of useful tools for finding, downloading, and visualizing it.

6.2.4 MATLAB:

MATLAB (MATrixLABoratory) is a multi-platform proprietary soft- ware developed by Mathworks. Matlab include an integrated development environment and a proprietary programming language specifically designed to ease matrix manipulations. Because of its features, and it powerful user interface, Matlab is particularly suitable for all applications involving signal and/or image analysis -or more in general, for all the applications in which is possible to represent data as a matrix.

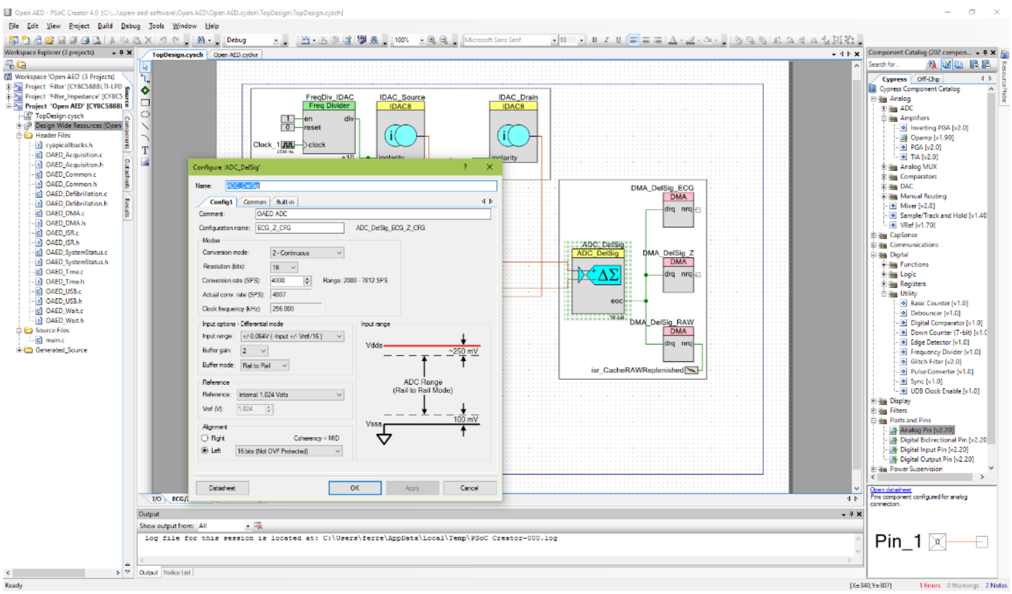

Figure 6.7 Signal Processing in Matlab

The later versions of Matlab also allow the creation of user interfaces, and interfacing with programmable development boards -such as Arduino-, or programs written in other languages, including C, C++, C#, Java, Fortran and Python.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to *learn* and *apply* specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

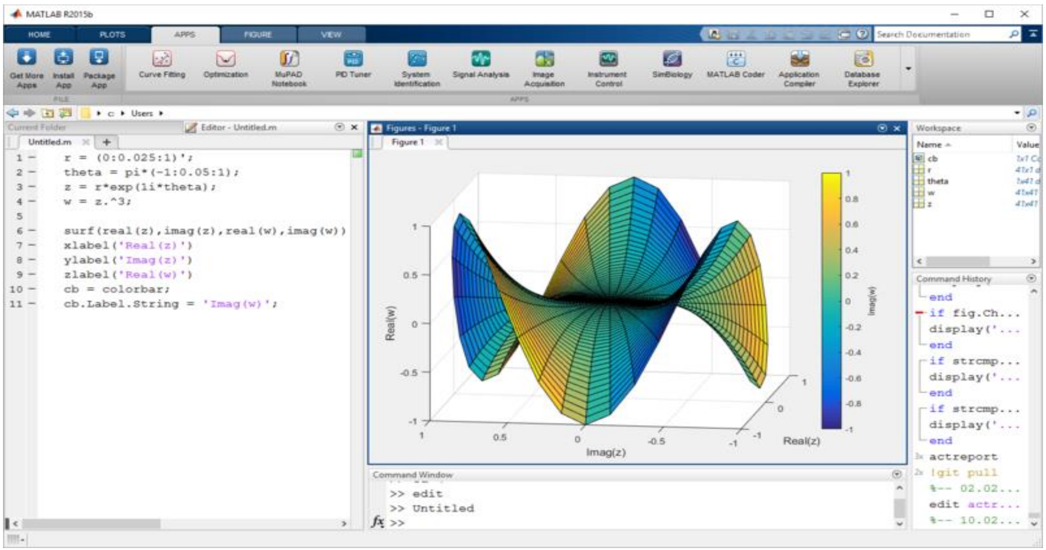

Figure 6.8 Graphical user Interface in Matlab.

The MATLAB system consists of five main parts:

The MATLAB language. This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

The MATLAB working environment. This is the set of tools and facilities that you work with as the MATLAB user or programmer. It includes facilities for managing the variables in your workspace and importing and exporting data. It also includes tools for developing, managing, debugging, and profiling M-files, MATLAB's applications.

Handle Graphics. This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete Graphical User Interfaces on your MATLAB applications.

The MATLAB mathematical function library. This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigen values, Bessel functions, and fast Fourier transforms.

The MATLAB Application Program Interface (API). This is a library that allows you to write C and Fortran programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

Matlab for Biomedical Signal Processing: Matlab Signal Processing Toolbox™ provides functions and apps to analyse, pre-process, and extract features from uniformly and non-uniformly sampled signals. The toolbox includes tools for filter design and analysis, resampling, smoothing, detrending, and power spectrum estimation. The toolbox also provides functionality for extracting features like change points and envelopes, finding peaks and signal patterns, quantifying signal similarities, and performing measurements such as SNR and distortion. It is also possible to perform modal and order analysis of vibration signals

Matlab is also used for many biomedical signal processing like EEG, ECG, EMG etc. where it aims at extracting significant information from biomedical signals and analyse signals and images in clinical medicine and the biological sciences.

CHAPTER 7

RESULTS AND FUTURE SCOPE

The algorithms were tested in Matlab on pre-available data set of pathological ECG signals obtained from Physio net.In addition, also somesignals obtained directly using the receptor paddles were used to additionally validate their specificity.

The resulting graph from the software shows the ECG of the victim and the heading of the plot specifies if the victim's ECG is normal or affected by a cardiac arrest. Also, the continued output shows that the variable y which detects abnormalities in the ECG shows 0 or nearly 0 if there exists irregular rhythms/ventricular fibrillation else it shows 1 for a normal heart rhythm.

One may observe through the hardware that a mild shock is produced in the case of detection on a cardiac arrest by designing codes compatible with Arduino UNO which retrieves signals by means of receptor paddles placed on the victim’s body. Therefore the software code should be designed in order to recognise thepresence of artefacts, or at least minimize their effects to avoid erroneousdecisions.

Hence, a futureversion of Off-Hospital AED may swap this algorithm for a more efficient one.

Figure 7.1 Therapeutic shocks from Defibrillators

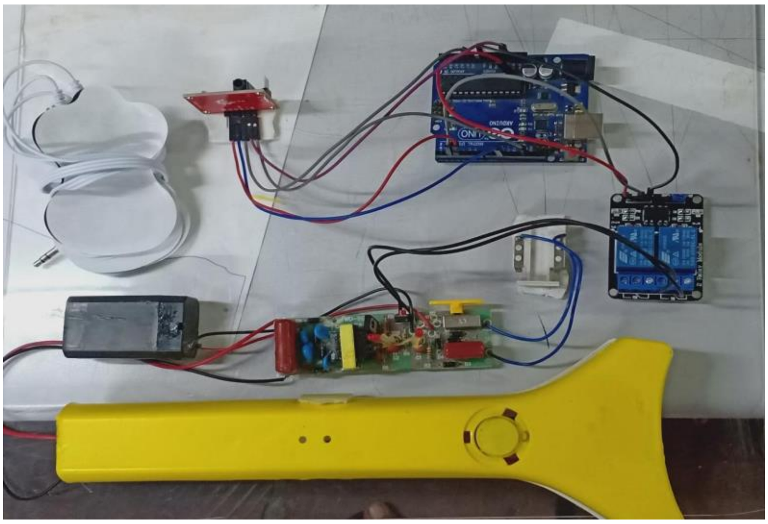

Figure 7.2 Defibrillator Prototype

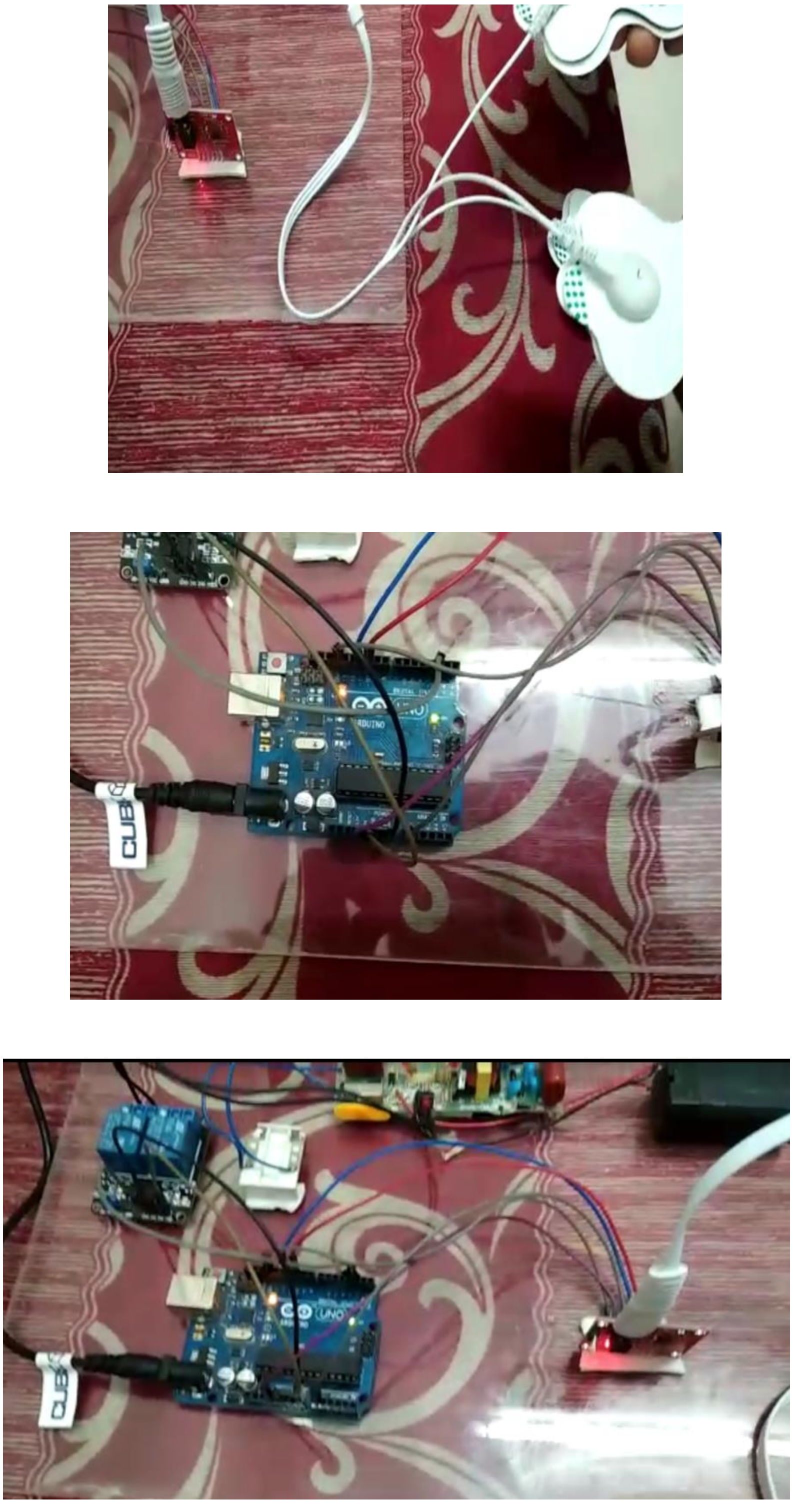

Figure 7.3 Defibrillator hardware circuit.

FUTURE SCOPE:

How effective are AEDs?

Extremely effective—especially compared with CPR without it. Depending on which statistics you read and whether the person receiving treatment is in a hospital or not, CPR is only 2%-18% effective. AEDs, by contrast, increase survival rates for victims of sudden cardiac arrest by more than 80% if the person receives treatment within the first three minutes.

Perhaps this is because ventricular fibrillation, a particularly deadly form of heart arrhythmia, is at the root of almost 90% of instances of cardiac arrests in adults. The only way to halt ventricular fibrillation is by using a defibrillator.

It’s not hard to use an AED—even for people with no prior medical training. If you own or work at a facility with an AED present, or anywhere someone might experience cardiac arrest, it is absolutely worth it to have an AED on the premises as well as people who know how to use one. AEDs are most effective within the first three minutes of a cardiac arrest—and it can take longer than that for bystanders to realize something is wrong and to call an ambulance

Social impact of AED on survival rates

An international group of researchers has discovered that those suffering from cardiac arrest in a public setting are twice as likely to survive if an automated external defibrillator (AED) was utilized before emergency help arrived.

It is estimated that about 1,700 lives are saved in the around the world per year by using an AED.Fewer than half (45.7 percent) of cardiac arrest victims get the immediate help they need before emergency responders arrive, in part because emergency medical services take, on average, between four and 10 minutes to reach someone in cardiac arrest, according to the AHA.

Impact of AED on human health

During a cardiac arrest, the electrical activity in the heart is disrupted. Without immediate CPR, the heart, brain and other vital organs aren't receiving enough oxygenated blood. For every minute without CPR, the chance of death increases by 10 percent, according to the AHA.

Sixty-six percent of victims who received a shock from AED survived to hospital discharge. The research stressed the critical difference in those who received cardiac care before responders arrived on the scene.

CHAPTER 8

CONCLUSION

The defibrillator is currently recommended as the best resuscitation technique which can be widely used by any layperson to deliver a shock manually. It has been shown to decrease mortality rates and neurological deficits of victims of out-of-hospital cardiac arrests. The proposed design of defibrillator is a powerful therapeutic tool. The advancements are making the defibrillators easier to use, cost effective and user convenient for public usage.The implementation of AED programs is a sustainable and culturally acceptable measure, bringing an undeniable benefit to society and public health.Observational studies have shown that in out of hospital cardiac arrest, public access defibrillators when used were associated with 40% median survival. When operated by non-dispatched lay first responders they have the highest likelihood of leading to survival.

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RUBRICS for Evaluation of Project work

Review-1 : Total Marks 15			
Design Readiness (Component procurement, Project plan & set up of environment)	Evaluation criteria		
	Good	Average	Poor
10 marks	Component procurement, Project plan & set up of environment is done as required	Component procurement, Project plan & set up of environment is done partially	Component procurement, Project plan & set up of environment is poorly done
	8 to 10 marks	5 to 7 marks	0 to 4 marks
Comparison with similar work	Evaluation criteria		
	Good	Average	Poor
5 marks	Comparison of the work is good against similar work	Comparison of the work is average against similar work	Comparison of the work is poor against similar work
	4 to 5 marks	3 marks	0 to 2 marks

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RUBRICS for Evaluation of Project work

Review-2 : Total Marks 40			
Partial Demo	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Partial demonstration of project work is satisfactory	Partial demonstration of project work is average	Partial demonstration of project work is poor
	8 to 10 marks	**5 to 7 marks**	**0 to 4 marks**
Tool learning	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Tool learning is satisfactory	Tool learning is partially satisfactory	Tool learning is poor
	8 to 10 marks	**5 to 7 marks**	**0 to 4 marks**
Project Report draft	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	The contents of the Draft project report is good	The contents of the Draft project report is average	Draft project report is poorly written.
	8 to 10 marks	**5 to 7 marks**	**0 to 4 marks**
Consistency Team work	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Demonstration of consistency in work progress and team work if good.	Demonstration of consistency in work progress and team work if average.	Demonstration of consistency in work progress and team work if poor.
	8 to 10 marks	**5 to 7 marks**	**0 to 4 marks**

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RUBRICS for Evaluation of Project work

Review-3 : Total Marks 45			
Functional demo	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Functional demonstration of project work is satisfactory	Functional demonstration of project work is average	Functional demonstration of project work is poor
	8 to 10 marks	**5 yo 7 marks**	**0 to 4 marks**
Results vs Requirements Further work	**Evaluation criteria**		
	Good	**Average**	**Poor**
5 marks	Results vs requirements of the project is satisfactory	Results vs requirements of the project is partially satisfactory	Results vs requirements of the project is poor
	4 to 5 marks	**3 marks**	**0 to 2 marks**
UGC approved State level or above	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	The work is published in UGC Journal + one in state level or above	Both papers are published in statel level or above	Only one paper is published
	6+4 marks	**4 +4 marks**	**4 to 6 marks** **other wise 0 marks**
Final Project report	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Project report is complete and correct in all respects	Project report is complete and correct partially.	Project report's completeness and correctness is poor
	8 to 10 marks	**5 to 7 marks**	**0 to 4 marks**
Presentation & PPT quality	**Evaluation criteria**		
	Good	**Average**	**Poor**
10 marks	Presentation and PPT quality is good	Presentation and PPT quality is average	Presentation and PPT quality is poor
	8 to 10 marks	**5 yo 7 marks**	**0 to 4 marks**

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8th SEMESTER PROJECT REVIEW - 1
2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs.Jayasudha.B.S.K

Sl No	**USN**	**Student Name**	**CO1(10)** Design Readiness (Component procurement, Project plan & set up of environment)(10)	**CO3(5)** Comparison with similar work(5)	**Total (15)**
1	1KS16EC044	MADHU. G	9	2	11
2	1KS16EC079	SAHANA D	8	1	9
3	1KS16EC080	SAHANA K G	8	2	10
4					

Evaluator Name **Mrs.Jayasudha.B.S.K**

Project Coordinators **Dr. B Sudarshan**
Mrs. Sahana Salagere

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8th SEMESTER PROJECT REVIEW - 1

2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs.Jayasudha.B.S.K

Sl No	USN	Student Name	CO1(10) Design Readiness (Component procurement, Project plan & set up of environment)(10)	CO3(5) Comparison with similar work(5)	Total (15)
1	1KS16EC044	MADHU, G	9	2	11
2	1KS16EC079	SAHANA D	9	3	12
3	1KS16EC080	SAHANA K G	9	2	11
4					

Evaluator Name **Dr.Surekha.B**

Project Coordinators **Dr. B Sudarshan**
Mrs. Sahana Salagere

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8th SEMESTER PROJECT REVIEW - 1

2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs.Jayasudha.B.S.K

Sl No	USN	Student Name	CO1(10) Design Readiness (Component procurement, Project plan & set up of environment)(10)	CO3(5) Comparison with similar work(5)	Total (15)
1	1KS16EC044	MADHU, G	7	3	10
2	1KS16EC079	SAHANA D	7	4	11
3	1KS16EC080	SAHANA K G	7	4	11
4					

Evaluator Name **Dr.P.Joy Prabhakaran**

Project Coordinators **Dr. B Sudarshan**
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8th SEMESTER PROJECT REVIEW - 2
2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2 (10) Partial Demo (10)	CO3 (10) Tool learning (10)	CO4 (10) Project Report draft(10)	CO5 (10) Consistency Team work (10)	Total (40)
1	1KS16EC044	MADHU, G	9	9	9	9	36
2	1KS16EC079	SAHANA D	8	10	9	8	35
3	1KS16EC080	SAHANA K G	8	9	8	8	33

Evaluator Name **Mrs.Jayasudha.B.S.K**

Project Coordinators **Dr. B Sudarshan**
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8th SEMESTER PROJECT REVIEW - 2
2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2 (10) Partial Demo (10)	CO3 (10) Tool learning (10)	CO4 (10) Project Report draft(10)	CO5 (10) Consistency Team work (10)	Total (40)
1	1KS16EC044	MADHU, G	9	6	9	10	34
2	1KS16EC079	SAHANA D	9	6	9	10	34
3	1KS16EC080	SAHANA K G	9	5	10	10	34

Evaluator Name **Dr.P.Joy Prabhakaran**

Project Coordinators **Dr. B Sudarshan**
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8th SEMESTER PROJECT REVIEW - 2
2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2 (10)	CO3 (10)	CO4 (10)	CO5 (10)	Total (40)
			Partial Demo (10)	Tool learning (10)	Project Report draft(10)	Consistency Team work (10)	
1	1KS16EC044	MADHU, G	8	8	8	8	32
2	1KS16EC079	SAHANA D	8	8	8	9	33
3	1KS16EC080	SAHANA K G	10	8	8	9	35

Evaluator Name **Dr.Surekha.B**

Project Coordinators **Dr. B Sudarshan**
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8th SEMESTER PROJECT REVIEW - 3
2019-20

Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2(10) Functional demo10)	CO3(5) Results vs Requirements Further work (5)	CO4(10) UGC approved (6) State level or above (4)	CO4(10) Final Project report(10)	CO5(10) Presentation (5) PPT quality (5)	Total (45)
1	1KS16EC044	MADHU, G	10	5	10	10	10	45
2	1KS16EC079	SAHANA D	10	5	10	10	10	45
3	1KS16EC080	SAHANA K G	10	5	10	10	10	45

Evaluator Nan **Mrs.Jayasudha.B.S.K**

Project Coord **Dr. B Sudarshan**
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Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2(10) Functional demo10)	CO3(5) Results vs Requirements Further work (5)	CO4(10) UGC approved (6) State level or above (4)	CO4(10) Final Project report(10)	CO5(10) Presentation (5) PPT quality (5)	Total (45)
1	1KS16EC044	MADHU, G	10	5	10	10	9	44
2	1KS16EC079	SAHANA D	10	5	10	10	9	44
3	1KS16EC080	SAHANA K G	10	5	10	10	10	45

Evaluator Nan **Dr.Surekha.B**

Project Coord **Dr. B Sudarshan**
Mrs. Sahana Salagere

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Project Group No	9
Project Title	Implementation of an off-Hospital rural and urban public access Defibrillator
Guide Name	Mrs. Jayasudha B S K

Sl No	USN	Student Name	CO2(10) Functional demo10)	CO3(5) Results vs Requirements Further work (5)	CO4(10) UGC approved (6) State level or above (4)	CO4(10) Final Project report(10)	CO5(10) Presentation (5) PPT quality (5)	Total (45)
1	1KS16EC044	MADHU, G	10	5	10	10	10	45
2	1KS16EC079	SAHANA D	10	5	10	10	10	45
3	1KS16EC080	SAHANA K G	10	5	10	10	9	44

Evaluator Nan Dr.P.Joy Prabhakaran

Project Coord Dr. B Sudarshan
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Visvesvaraya Technological University

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Branch : EC   Scheme : 2015   Semester : 8

Sl NO.	USN	15EC81	15EC82	15EC833	15EC84	15ECP85	15ECS86	STUDENT SIGNATURE
1	1KS14EC068	19	19	16	42	91	90	
2	1KS14EC085	18	14	12	44	80	85	
3	1KS14EC107	15	18	16	35	91	88	
4	1KS14EC117	15	18	16	45	91	88	
5	1KS15EC071	18	19	19	44	87	90	
6	1KS16EC002	20	20	20	50	98	88	
7	1KS16EC003	19	19	18	45	98	85	
8	1KS16EC004	19	20	20	50	98	90	
9	1KS16EC006	19	20	18	49	89	88	
10	1KS16EC009	20	20	20	50	98	88	
11	1KS16EC010	18	20	16	49	88	90	
12	1KS16EC011	19	20	20	48	94	88	
13	1KS16EC013	20	20	20	50	99	99	
14	1KS16EC014	18	18	19	48	88	85	
15	1KS16EC015	20	20	20	50	99	94	
16	1KS16EC016	19	20	20	46	91	90	
17	1KS16EC017	20	20	20	50	99	99	
18	1KS16EC018	20	20	20	47	93	98	
19	1KS16EC019	20	20	19	50	92	99	
20	1KS16EC020	20	20	20	48	88	85	
21	1KS16EC022	20	20	20	48	92	94	
22	1KS16EC023	20	20	19	48	90	99	
23	1KS16EC024	18	20	19	47	94	85	
24	1KS16EC025	19	20	20	46	95	94	
25	1KS16EC026	19	20	20	47	96	99	
26	1KS16EC028	20	20	20	44	95	99	
27	1KS16EC031	20	20	20	49	94	94	
28	1KS16EC032	20	20	20	50	99	99	
29	1KS16EC034	20	20	20	50	99	98	
30	1KS16EC035	19	20	20	50	98	90	
31	1KS16EC036	20	20	20	49	94	98	
32	1KS16EC037	19	20	20	47	92	90	
33	1KS16EC039	20	20	20	45	93	85	
34	1KS16EC040	20	20	20	50	96	98	
35	1KS16EC041	20	20	20	48	99	99	

Sl NO.	USN	15EC81	15EC82	15EC833	15EC84	15ECP85	15ECS86	STUDENT SIGNATURE
36	1KS16EC042	20	20	20	48	94	98	
37	1KS16EC043	19	20	19	46	91	85	
38	1KS16EC044	19	20	19	45	90	98	
39	1KS16EC045	20	20	20	48	90	94	
40	1KS16EC047	20	20	20	49	98	88	
41	1KS16EC048	19	19	18	43	90	85	
42	1KS16EC049	20	20	20	50	98	94	
43	1KS16EC050	20	20	20	50	95	90	
44	1KS16EC051	19	19	20	45	91	90	
45	1KS16EC052	20	20	20	50	92	98	
46	1KS16EC053	20	20	20	50	95	90	
47	1KS16EC054	20	20	20	50	95	98	
48	1KS16EC055	19	20	18	48	95	90	
49	1KS16EC056	18	20	19	45	89	90	
50	1KS16EC057	20	20	20	50	98	90	
51	1KS16EC058	20	20	20	50	99	90	
52	1KS16EC059	19	20	20	49	95	90	
53	1KS16EC060	20	20	16	46	90	85	
54	1KS16EC061	20	20	20	50	98	99	
55	1KS16EC062	18	20	18	43	89	85	
56	1KS16EC063	20	20	20	50	98	99	
57	1KS16EC064	20	20	20	50	95	99	
58	1KS16EC065	16	18	18	45	90	85	
59	1KS16EC067	19	20	20	49	95	99	
60	1KS16EC070	17	18	18	47	87	85	
61	1KS16EC071	20	20	20	50	97	94	
62	1KS16EC072	20	20	20	50	98	99	
63	1KS16EC073	20	20	19	50	95	99	
64	1KS16EC074	16	18	18	48	94	90	
65	1KS16EC076	20	20	20	50	97	99	
66	1KS16EC077	19	20	19	45	94	98	
67	1KS16EC078	20	20	20	50	99	99	
68	1KS16EC079	20	20	20	50	90	98	
69	1KS16EC080	20	20	20	48	90	98	
70	1KS16EC081	19	19	19	45	98	94	
71	1KS16EC082	19	18	20	50	94	90	
72	1KS16EC083	17	20	20	45	92	90	
73	1KS16EC084	20	19	19	45	90	85	
74	1KS16EC085	20	20	20	50	95	98	
75	1KS16EC087	20	20	19	47	93	90	
76	1KS16EC088	20	20	19	48	95	90	
77	1KS16EC089	20	20	20	49	92	90	

Sl NO.	USN	15EC81	15EC82	15EC833	15EC84	15ECP85	15ECS86	STUDENT SIGNATURE
78	1KS16EC090	17	20	19	48	96	90	
79	1KS16EC091	18	20	19	49	95	94	
80	1KS16EC092	17	19	19	45	93	90	
81	1KS16EC094	20	20	20	50	99	99	
82	1KS16EC095	20	20	20	49	91	94	
83	1KS16EC096	20	20	19	48	99	85	
84	1KS16EC097	18	19	16	47	90	94	
85	1KS16EC098	20	19	19	49	92	98	
86	1KS16EC099	20	20	20	49	98	90	
87	1KS16EC102	20	20	20	50	95	99	
88	1KS16EC103	19	20	18	45	92	98	
89	1KS16EC105	20	20	20	48	95	85	
90	1KS16EC106	19	19	19	45	91	94	
91	1KS16EC108	20	20	20	50	96	94	
92	1KS16EC109	20	20	20	50	96	98	
93	1KS16EC111	19	19	18	45	91	98	
94	1KS16EC112	20	20	19	46	90	94	
95	1KS16EC114	19	19	18	48	65	90	
96	1KS16EC115	20	20	20	50	98	94	
97	1KS16EC116	19	20	20	50	98	98	
98	1KS16EC117	20	20	20	47	90	90	
99	1KS16EC118	20	20	20	45	90	94	
100	1KS16EC119	20	20	19	48	96	94	
101	1KS16EC120	20	20	20	47	90	90	
102	1KS16EC401	16	18	16	35	90	85	
103	1KS16EC406	19	19	18	44	90	94	
104	1KS16EC416	17	19	17	35	75	85	
105	1KS16EC419	19	19	18	35	75	90	
106	1KS16EC430	18	19	18	44	90	90	
107	1KS17EC400	19	20	20	44	92	90	
108	1KS17EC402	18	20	18	41	87	85	
109	1KS17EC404	19	20	20	46	92	94	
110	1KS17EC406	20	20	20	46	95	85	
111	1KS17EC407	19	19	17	45	92	85	
112	1KS17EC408	19	19	17	42	65	94	
113	1KS17EC409	19	20	20	45	80	94	
114	1KS17EC413	20	20	20	48	80	90	
--x--	Faculty Signature							----XXXXXXX----

* - values are either optional subjects or the faculty has not yet entered the marks

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