SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203.

DEPARTMENT OF MEDICAL ELECTRONICS

LABORATORY MANUAL

1910505 – MEDICAL EQUIPMENT LABORATORY

Regulation - 2019

Semester/Branch : V Semester/MDE

Academic Year : 2022 -23(ODD)

Prepared By : Dr R Dhanush (Sr. G)/MDE

SRM VALLIAMMAI ENGINEERING COLLEGE

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DEPARTMENT OF MEDICAL ELECTRONICS

VISION OF THE INSTITUTE

Educate to excel in social transformation

MISSION OF THE INSTITUTE

• To contribute to the development of human resources in the form of professional engineers and managers of international excellence and competence with high motivation and dynamism, who besides serving as ideal citizen of our country will contribute substantially to the economic development and advancement in their chosen areas of specialization.

• To build the institution with international repute in education in several areas at several levels with specific emphasis to promote higher education and research through strong institute-industry interaction and consultancy.

VISION OF THE DEPARTMENT

To excel in the field of electronics and communication engineering and to develop highly competent technocrats with global intellectual qualities.

MISSION OF THE DEPARTMENT

M1: To educate the students with the state of art technologies to compete internationally, able to produce creative solutions to the society`s needs, conscious to the universal moral values, adherent to the professional ethical code

M2: To encourage the students for professional and software development career

M3: To equip the students with strong foundations to enable them for continuing education and research.

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PROGRAM OUTCOMES

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME (PSOs)

PSO1: Ability to apply the acquired knowledge of basic skills, mathematical foundations, principles of electronics, modelling and design of electronics-based systems in solving engineering Problems.

PSO2: Ability to understand and analyze the interdisciplinary problems for developing innovative sustained solutions with environmental concerns.

PSO3: Ability to update knowledge continuously in the tools like MATLAB, NS2, XILINIX and technologies like VLSI, Embedded, Wireless Communications to meet the industry requirements. PSO4: Ability to manage effectively as part of a team with professional behaviour and ethics.

SYLLABUS

1910505 - MEDICAL EQUIPMENT LABORATORY **L T P C**

0 0 4 2

OBJECTIVES:

The student should be made to:

- ✓ To familiarize with the bio signals such as ECG and EEG.
- ✓ To provide practice on recording and analysis of different Bio potentials.
- ✓ To study the function of different Therapeutic equipments.
- ✓ To perform electrical safety measurements of any medical equipments.
- ✓ To work with drug delivery system and to understand the measurements involved in it.

LIST OF EXPERIMENTS:

1. Simulation of ECG – detection of QRS complex and heart rate.
2. Study of shortwave and ultrasonic diathermy.
3. Study of biotelemetry.
4. Electrical safety measurements.
5. Measurement of Respiratory parameters using spirometry.
6. Study of medical stimulator.
7. Study of ESU – cutting and coagulation modes.
8. Recording of Audiogram.
9. Design of ECG amplifier, recording and analysis using Lab View.
10. A visual acuity measurement.
11. Simulation of EEG – record the EEG waveforms.
12. Measurement of drug delivery system by using syringe pump.
13. Measurement of drug delivery system by using infusion pump.
14. Study of OPG-Orthopantomogram

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this lab course, the student would be able to,

- ✓ Analyze the various Bio medical signals such as ECG, EEG.
- ✓ Do recording and analysis of different Bio potentials.
- ✓ Check the electrical safety of any medical equipment.
- ✓ Expl0ain about the concept and use of therapeutic Equipments.
- ✓ Perform measurements in drug delivery systems.

LIST OF EXPERIMENTS

CYCLE I

1. Simulation of ECG – Detection of QRS Complex and Heart Rate
2. Design of ECG amplifier, Recording and Analysis using Lab View
3. Study of Biotelemetry
4. Study of Medical stimulator.
5. Electrical Safety Measurements.
6. Simulation of EEG – record the EEG waveforms
7. Study of OPG-Orthopantomogram

CYCLE II

8. Study of Shortwave and Ultrasonic Diathermy
9. Study of ESU – Cutting and Coagulation modes
10. Recording of Audiogram
11. Measurement of Respiratory parameters using Spirometry.
12. A visual Acuity measurement
13. Measurement of drug delivery system by using syringe pump
14. Measurement of drug delivery system by using infusion pump

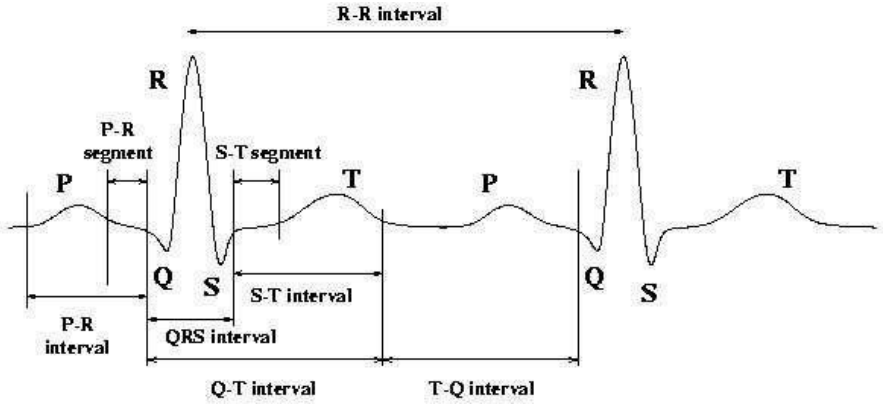
Ex.No: 1 SIMULATION OF ECG – DETECTION OF QRS COMPLEX ANDHEART RATE

Aim: To observe ECG waveform of a subject (Human) using all leads of standards bipolar leads configuration [(12-Leads system with 4-Limb leads- 3-Unipolar and 3- Bipolarleads, 6- Thoracic leads (unipolar)]

Apparatus Required:

- Heart Rate monitor cum ECG Trainer
- ECG Electrodes
- Connector and Oscilloscope.

Diagram:



Theory:

An ECG is simply a representation of the electrical activity of the heart muscle as it changes with time, usually printed on paper for easier analysis. Like other muscles, cardiac muscle contracts in response to electrical depolarization of the muscle cells. It is the sum ofthis electrical activity, when amplified and recorded for just a few seconds that we know asan ECG.

It will be clear from above that the first structure to be depolarized during normal sinus rhythm is the right atrium, closely followed by the left atrium. So the first electrical signal on a normal ECG originates from the atria and is known as the P wave.

Although there is usually only one P wave in most leads of an ECG, the P wave is in fact the sum of the electrical signals from the two atria, which are usually superimposed. There is then a short, physiological delay as the atrioventricular (AV) node slows the electrical depolarization before it proceeds to the ventricles. This delay is responsible for the PR interval, a short period where no electrical activity is seen on the ECG, represented by a straight horizontal or „isoelectric" line.

Depolarization of the ventricles results in usually the largest part of the ECG signal (because of the greater muscle mass in the ventricles) and this is known as the QRS complex.

The Q wave is the first initial downward or „negative" deflection

The R wave is then the next upward deflection (provided it crosses the isoelectric line and becomes "positive")

The S wave is then the next deflection downwards, provided it crosses the isoelectric line to become briefly negative before returning to the isoelectric baseline. In the case of the ventricles, there is also an electrical signal reflecting repolarisation of the myocardium. This is shown as the ST segment and the T wave.

The ST segment is normally isoelectric, and the T wave in most leads is an upright deflection of variable amplitude and duration.

The recording of an ECG on standard paper allows the time taken for the various phases of electrical depolarisation to be measured, usually in milliseconds. There is a recognized normal range for such „intervals":

PR interval (measured from the beginning of the P wave to the first deflectionof the QRS complex). Normal range 120 – 200 ms (3 – 5 small squares on ECGpaper).

QRS duration (measured from first deflection of QRS complex to end of QRS complex at isoelectric line). Normal range up to 120 ms (3 small squares on ECG paper).

QT interval (measured from first deflection of QRS complex to end of T wave at isoelectric line). Normal range up to 440 ms (though varies with heart rate and may be slightly longer in females)

Procedure:

- Connect the instrument to the mains.(Mains cords given.)
- Connect the Transducer to system, now make the Instrument ON.
- Now switch ON CRO (Use storage CRO)put the CRO on storage mode,
- Mode switch at DC position
- Time / Div Knob on the mS Division.
- Voltage / Div Knob on the 5V. (Change the position as per signal)
- Now connect the CRO to the instrument.
- Check the ground; if not proper make arrangement for that.
- Now connect the transducer to subject with different lead configuration andobtain the ECG wave form from CRO.

Result: Thus the Electrical waveform is obtained from ECG according to position of leads.

VIVA QUESTIONS

1. What is meant by ventricular fibrillation?
2. What is arrhythmia?
3. What are the different types of ECG load configuration?
4. What are the differences between normal and abnormal ECG waves?
5. .Write the physiological nature of ECG waveform?

EX NO: 2 DESIGN OF ECG AMPLIFIER, RECORDING AND ANALYSIS USING LAB VIEW

Aim: To design an ECG amplifier and to record and analyze using LAB VIEW software.

HARDWARE

- Data Acquisition Unit
- Microcontroller Based
- 1000 Samples / Second / Channel
- Channels
- Baud rate of 115200 Bits/Second
- Optical isolation
- Serial Port/RS232 Connectivity
- Advanced Filters
- Battery Powered.

ECG Amplifier

Wire patient cable

Input impedance > 5 M ohmCMRR >

80 Db

Gain = x 1K Max

Frequency Response- 1 Hz to 48 Hz.

Data Acquisition Unit

Data acquisition is the sampling of the real world to generate data that can be manipulated bya computer. Sometimes abbreviated DAQ or DAS, data acquisition typically involves acquisition of signals and waveforms and processing the signals to obtain desired information. The components of data acquisition systems include appropriate sensors that convert any measurement parameter to an electrical signal, then conditioning the electrical signal which can then be acquired by data acquisition hardware. Acquired data are displayed,analyzed, and stored on a computer, either using vendor supplied software, or custom displays and control can be developed using various general purpose programming

languages such as BASIC, C, FORTRAN, Java, Lisp, Pascal. Specialized programming languages used for data acquisition include EPICS, used to build large scale data acquisition systems, LabVIEW, which offers a graphical programming environment optimized for data acquisition, and MATLAB which provides a programming language, and also built- in graphical tools and libraries for data acquisition and analysis.

NI-DAQ BNC2120

Since DAQ device acquire electrical signals, a transducer or a sensor must convert some physical phenomenon into an electrical signal. A DAQ can also simultaneously produce electrical signals. These signals can either intelligently control mechanical systems or provide a stimulus so that the DAQ can measure a response. Most DAQ devices have four standard elements: analog input (AI), analog output (AO), digital I/O (DIO), and counter/timers. The 6014E features 16 channels (eight differentials) or analog input, two channels of analog output, 1nd 8 lines of digital I/O. These devices use the National Instruments DAQ -STC system-timing controller for time-related functions. The DAQ-STC consists of three timing groups that control analog input, analog output, and general-purpose counter/timer functions. These groups include a total of seven 24-bit and three16-bit counters and a maximum timing resolution of 50ns. The DAQ-STC makes possible such applications as buffered pulse generation, equivalent time sampling andseamless changing of the sampling rate. PC based data acquisition gives users the flexibility to develop measurement solutions for virtually any applications.

SOFT WARE DESCRIPTION

NI LabVIEW is the graphical development environment for creating flexible and scalable test, measurement, and control applications rapidly and at a minimal cost. With LabVIEW, engineers and scientists interface with real world signals, analyze data for meaningful information, and share results and applications. Regardless of experience, LabVIEW makesdevelopment fast and easy for all users. LabVIEW programs are called virtual instruments, or VI, because their appearance and operation imitate physical instruments, such as oscilloscopes and multi meters. LabVIEW contains a comprehensive set of tools for acquiring, analyzing, displaying and storing data as well as tools for troubleshooting.

CREATING THE FRONT PANEL

To create the user interface for a VI, we place the controls and data displays for our measurement system on the front panel by choosing objects from the controls palette, such as numeric displays, knobs, meters, gauges, thermometers,tanks, LEDs, charts and graphs. Then, we control our system at runtime by simply operating the various objects on the front panel, whether it is moving a slide, zooming in on agraph, a value from the keyboard.

CONSTRUCTION OF BLOCK DIAGRAM

We can construct a block diagram to define the behaviour of a VI without worrying aboutthe many syntactical details of conventional programming. We can select objects or icons from the Functions palette and connect them with virtual wires to pass data from one block to the next. These blocks range from simple

arithmetic functions to advanced acquisition and analysis routines, to network and file I/O operations

GRAPHICAL COMPILER

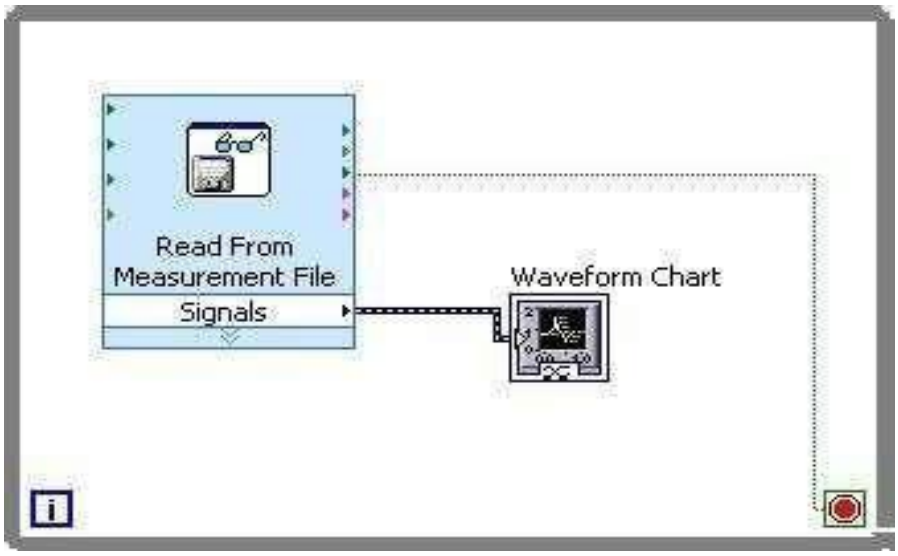
In many applications, execution speed is a critical consideration. LabVIEW is the only graphical programming system with a compiler that generates optimized code with execution speeds comparable to compiled C program. To further improveperformance, you can analyzed and optimize time-critical sections of code with the built- in-profiler. In this way, you can increase productivity with graphical programming without sacrificing execution speed.

LABVIEW COMPETITIVE ADVANTAGE

- LabVIEW users report significant productivity gains when compared totraditional development tools.
- Preserve capital investment in computer and instrumentation hardware.
- Empowers a larger group of users to develop their own solutions.
- Completes the entire application without the addition of more complicated development tools.
- Simplifies complicated development tasks with powerful add-on tools for tasks such as data analysis and visualization , report generation, and corporate database connectivity.
- Ensures successful development through National Instruments support servicesand a huge user network.

EXPERIMENTAL SETUP

The Figure shows the Lab VIEW setup for visualizing the recoded ECG signal.

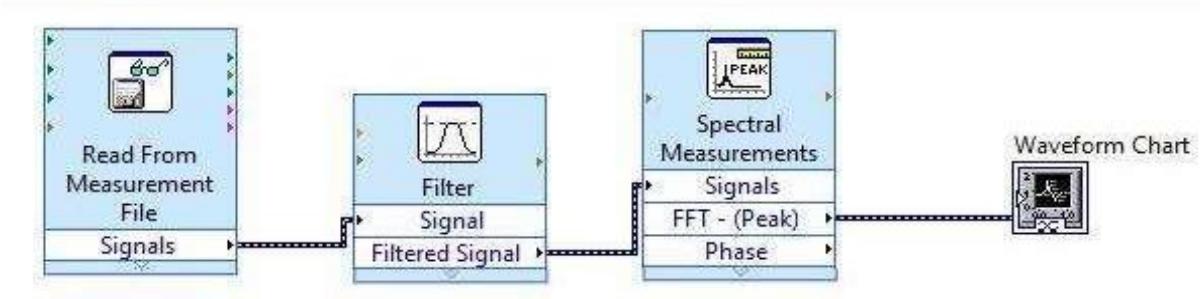


The setup shown in Figure can be created using the following steps

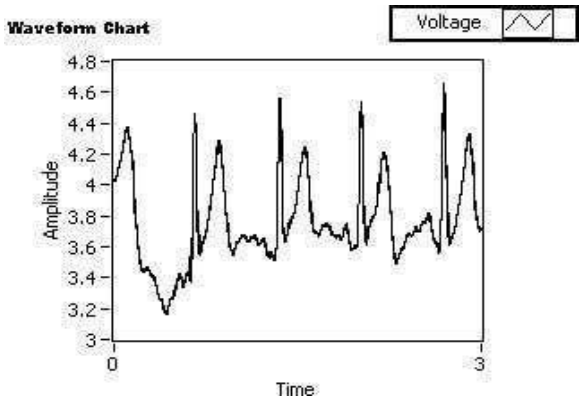
- Go to block diagram, then function Express Input Read File

- Go to front panel controls express graph indicator chart
- Select wire tool then make connection b e t w e e n r e a d from measurement file signals block and waveform chart
- Got functions Exec control select while loop

ECG SIGNAL PROCESSING USING WINDOWING TECHNIQUES



MODEL GRAPH



RESULT

Hence the ECG amplifier is designed using LAB VIEW software and results were obtained.

VIVA QUESTIONS

1. What is DAQ?
2. What is LabVIEW?
3. How do you analyse ECG signal in Lab view?
4. How much gain is to be set for designing ECG amplifier?
5. How much frequency is to be set for designing ECG amplifier?

EX NO: 3 STUDY OF BIOTELEMETRY

AIM: To understand the transmission and reception of biological signal using single channel telemetry system

Equipments Required:

- ECG Amplifier
- Low Pass Filter – 2 Nos. FM Modulator
- FM Transmitter
- FM Receiver
- FM Demodulator
- Charger
- Battery – 2 Nos. Electrodes

Theory:

Telemetry is a system of sending data, usually measurements, over a distance. Telemetricdata may be physical, environmental or biological. Telemetry is typically used to gather data from distant, inaccessible locations, or when data collection would be difficult or dangerous for a variety of reasons. In telemetry, specialized instruments carry out measurements of physical quantities, and store or transmit the resulting signal, often after some initial signal processing or conversion. Biotelemetry is the electrical measuring, transmitting, and recording of qualities, properties, and actions of organisms and substances, usually by means of radio transmissions from a remote site. There are single channel and multi-channel telemetry systems. For a single channel system, a miniature battery operatedradio transmitter is connected to the electrodes of the subject. This transmitter broadcasts the bio potential over a limited range to a remotely located receiver, which detects the radio signals and recovers the signal for further processing. In this situation there is a negligible connection or stray capacitance between the electrode circuit and rest of the system.

Block Diagram Description:

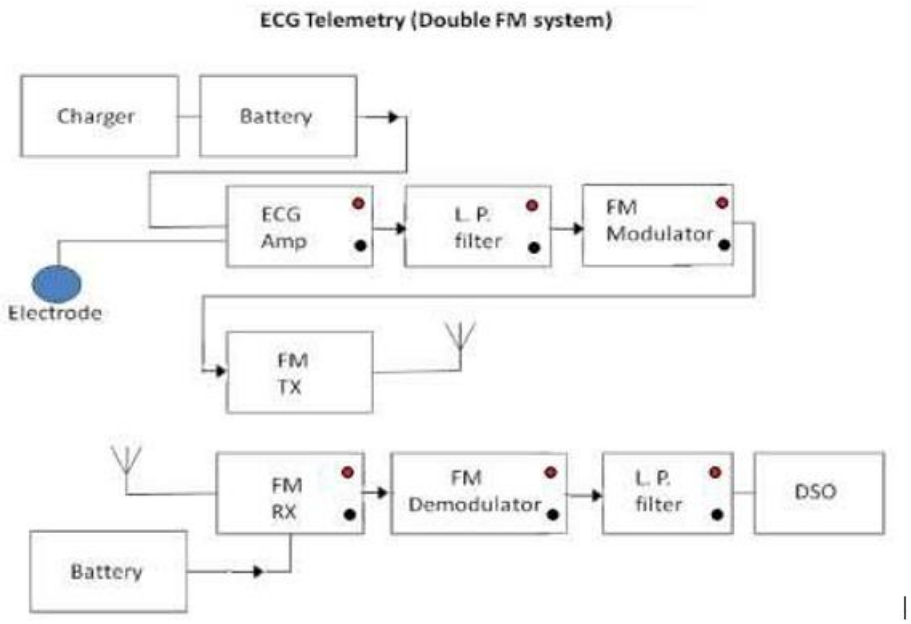
ECG Amplifier

ECG has amplitude of only about 1 mV, so to detect it an amplifier is required. The ECG amplifier used here has a Gain of 1000 and CMRR of more than 80dB.

Low Pass Filter

A low-pass filter allows low-frequency signals but attenuates (reduces the amplitude of) signals with frequencies higher than the cutoff frequency. When the ECG is amplified, the noise is amplified too, and often swamps the ECG signal. The noise is usually of a higher frequency than the ECG. So the noise can be reduced by low-pass

filtering.



Block diagram

FM Modulator

Modulation is used to embed a message (voice, image, data, etc.) on to a carrier wave for transmission. A bandlimited range of frequencies that comprise the message (baseband) is translated to a higher range of frequencies. The bandlimited message is preserved, i.e. every frequency in that message is scaled by a constant value. Here the incoming ECG signal is modulated at around 110MHz. The modulated ECG signal is given to the FM Transmitter.

FM Transmitter

FM Transmitter sends a signal (typically 4-20mA) from a process location to a central location for control and monitoring. Here FM transmitter transmits the modulated ECG signal.

FM Receiver

A receiver receives its input through an antenna. It receives the modulated signal from the transmitter. The receiver then passes on the information to the FM Demodulator where the ECG signal is demodulated to obtain the original ECG signal. **FM Demodulator**

Demodulation, in radio is the technique of separating a transmitted audio frequency signal from its modulated radio carrier wave. Here the modulated ECG signal is demodulated at a frequency of around 100Hz and the original ECG signal is recovered.

Procedure:

Connect the modules as per the block diagram. Switch ON the battery. Connect the ring electrodes to the subject. View the transmitted signal on the DSO.

The various outputs from each of the modules can be viewed on the DSO byconnecting the output pin to the desired module.

Result: Thus we understand the transmission and reception of biological signal using a telemetry system.

VIVA QUESTIONS

1. Define telemetry.
2. What are the types of Telemetry?
3. What is the purpose of demodulator?
4. How does telemetry work?
5. Why do we use a LPF?

EX NO: 4 STUDY OF MEDICAL SIMULATOR

Aim: Study of Normal Sinus Rhythm (Lead II) using pacemaker.

Equipments required:

Pacemaker Trainer2 mm

Patch cord

Oscilloscope (DS1102C 100 MHz, 400MSa/s)

Theory:

The rhythmic beating of the heart is due to the triggering pulses that originate in an area of specialized tissue in the right atrium of the heart. This area is known as (SA Node) Sino-Atrial Node. In abnormal situations, if this natural pacemaker ceases to function or becomes unreliable or if the triggering pulse does not reach the heart muscles because of blocking by the damage tissues, the natural and normal synchronization of the heart action gets disturbed. When monitored, this manifests itself through a decrease in the heart rate and changes in the electrocardiogram (ECG) waveforms. By giving external electrical stimulations impulses to the heart muscles, it is possible to regulate the heart rate. These impulses are given by an electronic instrument called as Pacemaker. Pacemaker basically consist of two parts, an electronic unit which generates stimulating impulses of controlled rate and amplitude known as pulse generator while other part is lead which carry the electrical pulses from pulse generator to the heart.

Procedure:

- Connect the instrument to the mains.(Mains cords given.)
- Instrument ON by mains Switch, the switch will be lighted.
- Now switch ON CRO (Use storage CRO)
- Put the CRO on storage mode,
- Mode switch at DC position Time / Div Knob on the msec Division.
- Voltage / Div Knob on the 5V. (Change the position as per signal)
- Now connect the CRO to the instrument.
- Check the ground; if not proper make arrangement for that.
- Connect the instrument to the mains, Put all knob at zero position.
- Instrument ON by mains Switch.
- Now switch ON CRO (Use storage CRO)
- Put the CRO on storage mode, Mode switch at DC position, Time / Div Knob on themS Division, Voltage / Div Knob on the 5V. (Change the position as per output)

- Now connect the CRO at electrodes output terminal
- Check the ground; if not proper make arrangement for that.
- Modes switch on Int. or Ext.
- For measurement Int. connect 1k resistances & Ext. 10k resistance.
- Very the Rate & Amp pot & measure the Output.
- Sync. Input - Connect the SYNC input. Sync LED On and OFF
- If any noise is found on CRO, check the Ground. If Ground or electrodes are notproper the signal gets distorted.

Result:

Thus the actual working of pacemaker using pacemaker simulator was studied.

VIVA QUESTIONS

1. What is the role of pacemaker?
2. Distinguish between internal and external pacemakers.
3. What are the types of pacemakers based on operation?
4. What is the power source employed in implantable pacemakers?
5. What is arrhythmia?

EX NO: 5 ELECTRICAL SAFETY ANALYSER

Aim: To determine the amount of leakage current and insulation level of the given equipment and to state about the electrical safety of the equipment.

Apparatus required:

- Insulation tester.
- IACA leakage tester.
- RCCB
- Continuity test.
- Supply.

Theory:

It operates by measuring the current between the conductors using a differential current transformer and opening the device contacts if there is a balance fault. Normal tripping current is in the region of 6mA to 30mA in some cases going up to 100mA. It is also referredto as Ground Fault Interrupter. RCCB are designed to prevent electrocution by detecting the leakage current. They are intended to operate within 25 – 40 milliseconds before electric shock can drive the RCP serve more as an additional fire safety protection them as an effective protection against the risks of electrical shock.

Measuring procedure:

I. Leakage current measurement:

- Connect the device to be tested to the break out box. Measure the load current of thedevice.
- Clamp the leakage meter to the earth wire and measure.
- Select the "power ON/OFF/Hold Switch" to ON position.
- Select the "200mA/20A/200A" to"200mA" position.
- Press the trigger to open the "current sense jaw".
- Read AC mA leakage current on the display directly
- Note down the values of the leakage current should the leakage current be greaterthan 30mA the device will automatically trip with a click sound.

II. OHM measurement:

- Connect black test plug into "-"terminal.
- Connect red test plug into "+" terminal.
- Engage function push button "200MΩ /500v" or 1000 µv/1000v on function scale.
- Connect the test alligator clips into circuit under test.
- Push the test switch to "ON" position.

Result:

Amount of leakage current and insulation level of the given equipment is tested

VIVA QUESTIONS

1. Name few tests that can be conducted by a electrical safety analyzer.
2. What is meant by let go current?
3. How will you test the isolated power system?
4. Why does ECG unit have an isolation circuitry as a mandatory requirement?
5. Give some precautions to minimize Electric shock hazards.

EX NO: 6 STUDY OF SHORTWAVE AND ULTRASONIC DIATHERMY

Aim: To study the working of Short wave and Ultrasound diathermy unit.

Apparatus Required:

- Shortwave diathermy unit.
- Pad electrodes.
- Ultrasound diathermy unit.

Description:

Diathermy involves heating deep muscular tissues. When heat is applied to the painful area, cellular metabolism speeds up and blood flow increases. The increased metabolism and circulation accelerates tissue repair. The heat helps the tissues relax and stretch, thus alleviating stiffness. Heat also reduces nerve fiber sensitivity, increasing the patient's pain threshold.

There are three methods of diathermy. In each, energy is delivered to the deep tissues, where it is converted to heat. The three methods are:

Shortwave diathermy: The body part to be treated is placed between two capacitor plates. Heat is generated as the high-frequency wave's travel through the body tissues between the plates. Shortwave diathermy is most often used to treat areas like the hip, which is covered with a dense tissue mass. It is also used to treat pelvic infections and sinusitis. The treatment reduces inflammation. Most machines function at 27.33 megahertz.

Ultrasound diathermy: In this method, high-frequency acoustic vibrations are used to generate heat in deep tissue.

Surgical diathermy: The use of electro cautery for coagulation or cauterization, as for sealing a blood vessel, resulting in local tissue destruction

Diathermy is also used in surgical procedures. Many doctors use electrically heated probes toseal blood vessels to prevent excessive bleeding. This is particularly helpful in neurosurgery and eye surgery. Doctors can also use diathermy to kill abnormal growths, such as tumors, warts, and infected tissues.

Shortwave diathermy (SWD) Theory

Short Wave diathermy current is a high frequency alternating current. The heat energy obtained from the wave is used for giving relief to the patient. Its frequency is 27,120,000 cycles per second and the wavelength is 11 meter.

A shortwave diathermy unit is a device designed to generate radiofrequency radiation and transfer it, via cables and electrodes, to the area to be treated. The units can be operated in either a continuous wave or pulsed mode but both produce heat in deep tissue.

Two Forms of Shortwave Diathermy The units can be operated in either Continuous mode or in Pulsed mode

Two basic types of electrodes (applicators) are in use: Capacitor-type, Inductor type. In the first case tissue heating is basically due to the radiofrequency electric field, while for the inductive electrodes (coils), heating occurs by a combination of electric field effects and currents induced in the tissue by the magnetic field. The heating profile of the two mechanisms is somewhat different.

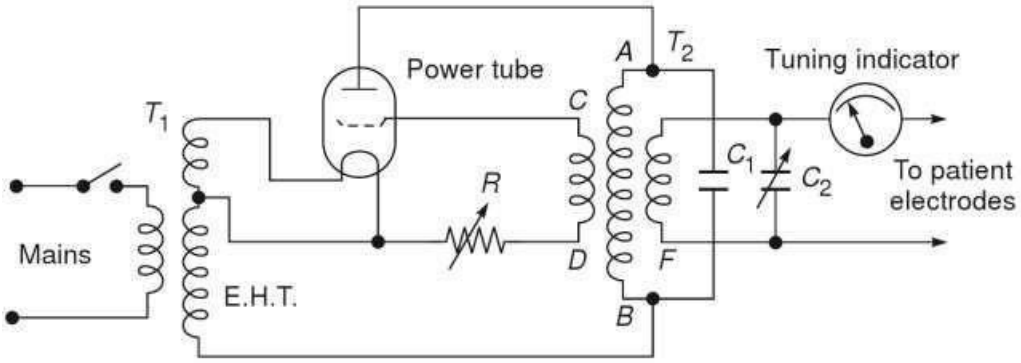
These devices are capable of generating a sufficiently high level of radiation that there maybe cause for concern for the safety of the gonads and, in the case of pregnant patients, the fetus. Improper use of the machine may result in burns and/or scalds and deep tissue or organdamage. It must be noted that the level of radiation present in the vicinity of a diathermy unit may be increased by the presence of nearby metallic objects or other units or by reflection from the wall. Care must be taken to ensure that the shortwave radiation does not cause interference with other equipment.

SWD is most commonly used for thermotherapy at a frequency of 27.12 MHz

Working Of Short Wave Diathermy

Shortwave diathermy heats the tissue by causing oscillations of electromagnetic energy of high frequencies. The physiologic effects of temperature occur at the site of the application and in distant tissue.

Circuit diagram of shortwave diathermy



The local effects occur due to the elevated local temperature which is associated withincreased local blood flow, capillary dilatation and capillary permeability.

It results in higher level tissue metabolism and more rapid transfer of nutritional ingredients to the end organs and tissues. It promotes faster healing. Short wave heat increases connective tissue elasticity, reduces muscle spasm, and sedates the nerve endings to change the pain threshold.

Distant changes from the heated target location include reflex vasodilatation and reduction of muscle spasm, increase in body temperature, respiratory and pulse rates and decreased blood pressure.

Diathermy increases white blood cell concentration in the area of chronic inflammation.

Ultrasound diathermyTheory:

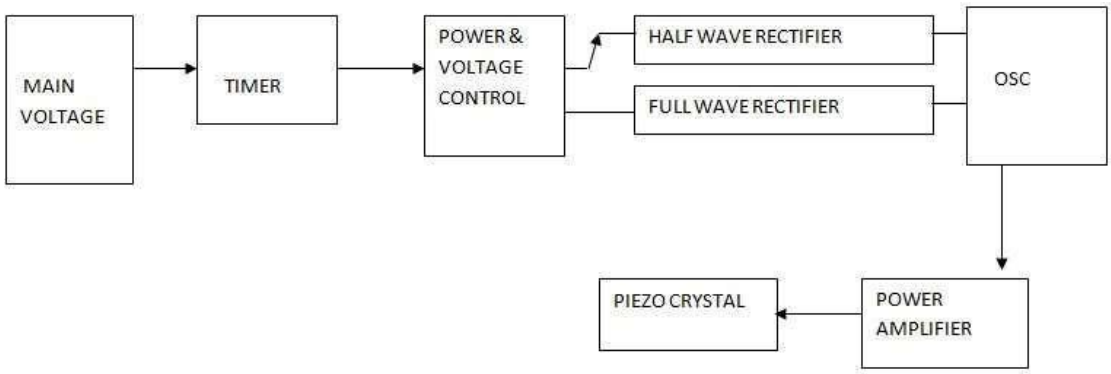
Ultrasound is sound above the limits of human hearing. The therapeutic effects of ultrasound result from the conversion of sound to heat energy. Ultrasound diathermy typically employs frequencies between 0.8 and 1 MHz.

Ultrasound diathermy is considered a deep heating modality in that most absorption occurs far beneath the skin. It is most commonly used to treat tendonitis and bursitis, musculoskeletal pain, degenerative arthritis, and contractures. Maximal heating may be limited by deep tissue factors and not by skin tolerance. Ultrasound may be applied directly by placing the applicator on the skin, or indirectly by immersing the body part and applicator in a water- filled container. Because of the importance of appropriate technique and inherent dangers, ultrasound diathermy should be applied by attained attendant and the devices are not appropriate for unsupervised home use. It is an electromagnetic wave different from sound waves. The frequencies of waves employed for medical purposes arebetween 5, 00,000 and 3,000,000 cycles/sec.

Generation of Ultrasonic Waves

Ultrasonic waves are generated by vibration of a Crystal mounted on a special head.

Block Diagram:



Ultrasound provides therapeutic benefit via thermal (continuous ultrasound) and non- thermal (pulsed ultrasound) effects.

Circuit Description:

The heart of the system is timed oscillator which produces the electrical oscillation ofrequired frequency. The oscillator output is given to the power amplifier which derives the piezoelectric crystals to generate ultrasound waves. Power amplification is achieved by replacing the transistor in a typical LC tuned colpitt oscillator by 4 power transistors placed in a bridge configuration. The delivery of the ultrasounds power to a patient is to be done for a given time. This is controlled by incorporating a timer to switch on the circuit.The timer can be mechanically spring loaded type or an electronic one, allowing time settingsfrom 0 to 30 minutes.

Result:

The study of Short wave and Ultrasound Diathermy was thus performed in a subject.

VIVA QUESTIONS

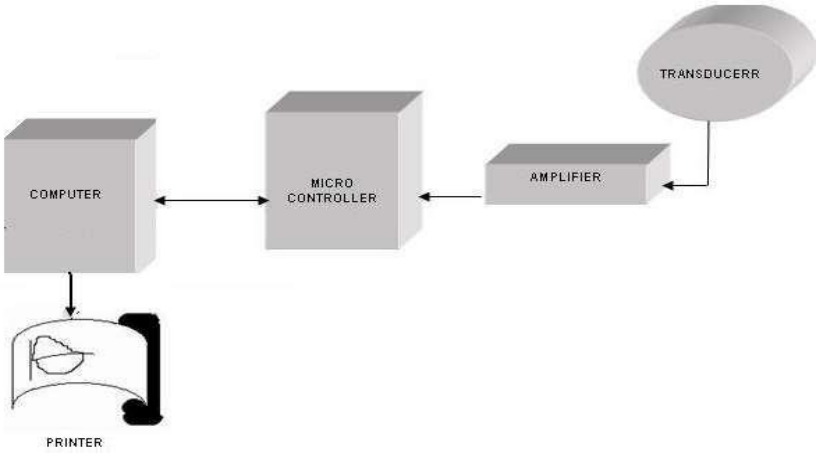
1. What is the method followed in diathermy?
2. What are the types of waveforms required for electro diagnosis?
3. What is the principle difference between cutting and coagulation
4. What is the principle of ultrasound diathermy?
5. Why microwave is better than short wave?

EX NO: 7 MEASUREMENT OF RESPIRATORY PARAMETERS USING SPIROMETRY

Aim: To measure the volume of air inspired and expired by the lungs.

Equipment Required: Spirometer

Block Diagram:



Microcontroller is powered through USB. The pulses that are generated in the transducer by the patients breathe gets amplified by the amplifier and sent to the Micro Controller. The Micro Controller processes data and transfer it to computer which is displayed on computer screen.

PERFORMING A SPIROMETRY TEST

In the performance of spirometry, the following steps should be taken:

- Fix the transducer into the transducer assembly. The transducer has an arrowon the surface. Insert the transducer in the direction indicated by the arrow. The transducer will click into position when correctly connected. Fix the mouthpiece (disposable or reusable) over this assembly. The mouthpiece will click into position when correctly connected. Connect the transducer assembly to the computer using theUSB cable.

  Train the patient in test performance. The patient's collaboration is essential to carry out the maneuvers correctly. Use a nose clip to allow air to flow only through the patient's mouth. The patient must sit upright holding the hand piece to their mouth and throughout the maneuver the patient should try to keep their back straight as much as possible.
- The patient should hold transducer hand unit in such a way that the air passage is completely unobstructed. Ensure the patient's hands, fingers or clothing, etc, are not obstructing the air flow. The area in front of the patient should also be kept clear to avoid back-draft of air entering the turbine, and

affecting the readouts.

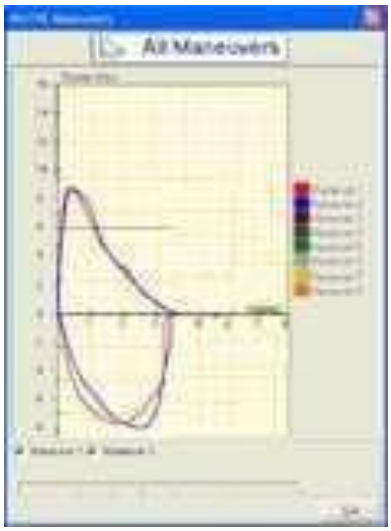
- Press the Start icon and select either the pre-medication or post medication in the dialog box which appears to specify which type of test is to be undertaken.
- Perform the maneuver.
- Click the Stop icon in the main menu. Alternatively, keep the transducer in place untilthe device detects the end of the expiratory maneuver according to ATS criteria. This criteria is satisfied when the volume accumulated during the last second lower than 0.03l
- After the maneuver is performed, the display screen will show the graphobtained. The maneuver number, will be shown either in the center column of the screen (FVC) or along the bottom of the screen (SVC and MVV).
- After each successive maneuver is performed, a dialog box, specific to the type of test, appears. The observed values of the current maneuver and the previous maneuver are compared. Based upon these readings, and the action suggested by the software, the user can accept or Reject the maneuver. If the maneuver is rejected then the observations are lost. If the maneuver is accepted then the readings get stored as a numbered maneuver. Only accepted maneuvers are added to thelist of maneuvers performed.
- Out of the list of accepted maneuvers, the user can carry out analysis.

PERFORMING THE FVC TEST

- Explain the general procedure to the patient
- Load Patient from the database. Click FVC. The FVC test screen is displayed.
- Ask the patient to begin relaxed tidal breathing through the mouth piece fixed overthe transducer and then to take a deep breath in
- Simultaneously click the Start button. Make the appropriate choice of the test (Pre Medication or Post Medication).
- Immediately after this the patient should blow out as hard and fast as possibleand continue blowing until no more air can be exhaled.
- Then the patient should take another deep breath back in, with the mouthpiece still inhis mouth, until the lungs are full.
- When finished the effort is complete.
- Repeat the test as required until adequate test data has been acquired, or until amaximum of eight acceptable maneuvers have been performed.

III. FVC Specific Features

The FVC screen shows space to obtain the Flow/Volume and Volume/Time graphics. The current maneuver being displayed is indicated by the blue arrow in the centre column of the screen. For example, maneuver 2 is pointed by the blue arrow.



RESULT:

Hence the air inspired and expired from the lungs was performed by using spirometer.

VIVA QUESTIONS

- How will you calculate the total lung capacity?
- What is residual volume?
- Does vital capacity vary person to person?
- What is nebulizer?
- What is plethysmography?

EX NO: 8 STUDY OF ESU (ELECTRO SURGICAL UNIT) – CUTTING AND COAGULATION MODE

Aim: To study and analyze the function and safety aspects of the electro surgerytechnique which is used in the Electro Surgical Unit.

Theory:

ELECTROSURGERY:

Electro surgery is the application of a high-frequency electric current to biological tissue as a means to cut, coagulate, desiccate, or fulgurate tissue. Its benefits include the ability to make precise cuts with limited blood loss. Electrosurgical devices are frequently used duringsurgical operations helping to prevent blood loss in hospital operating rooms or in outpatient procedures.

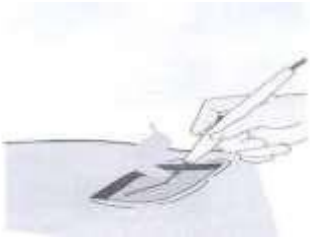
In electrosurgical procedures, the tissue is heated by an electric current. Electro surgery uses alternating current to directly heat the tissue itself. When this results in destruction of small blood vessels and halting of bleeding, it is technically a process of electro coagulation.

Electro surgery is commonly used in dermatological, gynecological, cardiac, plastic, ocular, spine, ENT, maxillofacial, orthopedic, urological, neuron- and general surgical procedures as well as certain dental procedures.

Electro surgery is performed using an electrosurgical generator (also referred to as power supply or waveform generator) and a hand piece including one or several electrodes, sometimes referred to as an RF Knife. The apparatus when used for cutting or coagulation in surgery is still often referred to informally by surgeons as a "Bovie," after the inventor.

TECHNIQUES: CUTTING:

The electrode touches the tissue, and sufficiently high power density is applied to vaporize its water content. Since water vapor is not conductive under normal circumstances, electric current cannot flow through the vapor layer. Energy delivery beyond the vaporizationthreshold can continue if sufficiently high voltage is applied (> +/-200 V) to ionize vapor and convert it into a conductive plasma. Vapor and fragments of the overheated tissue are ejected. Forming a crater. Electrode surfaces intended to be used for cutting often feature a finer wire or wire loop, as opposed to a more flat blade with a rounded surface.



COAGULATION:

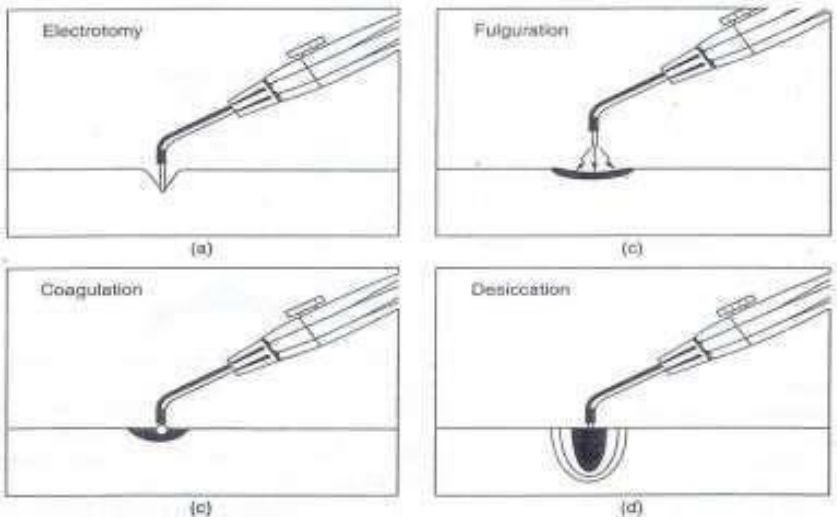
When the electrode is placed near the skin, high frequency current is sent to the tissue in the form of a burst, heating it locally so that it coagulates the tissue. Therefore it is performed using waveforms with lower average power, generating heat insufficient for explosive vaporization, but producing a thermal coagulum instead.

DESSICATION:

Electrosurgical desiccation occurs when the electrode touches the tissue open to air, and the amount of generated heat is lower than that required for cutting. The tissue surface and some of the tissue more deep to the probe dries out and forms a coagulum (a dry patch of dead tissue). This technique may be used for treating nodules under the skin where minimal damage to the skin surface is desired.

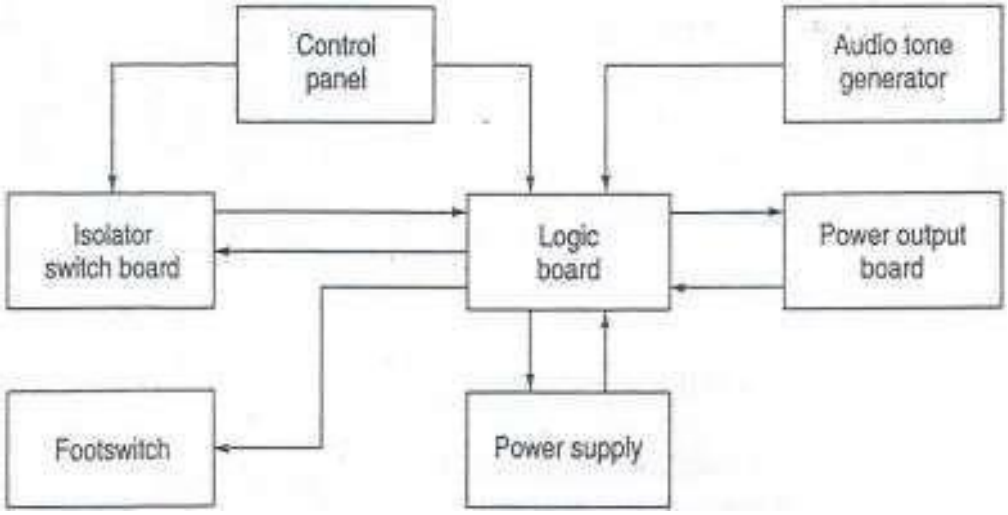
FULGURATION:

In fulguration mode, the electrode is held away from the tissue, so that when the air gap between the electrode and the tissue is ionized, an electric arc discharge develops. In this approach the burning to the tissue is more superficial, because the current is spread over the tissue area larger than the tip of electrode. Under these conditions, superficial skin charring or carbonization is seen over a wider area than when operating in contact with the probe, and this technique is therefore used for very superficial or protrusive lesions such as skin tags. Ionization of an air gap requires voltage in the kV range.

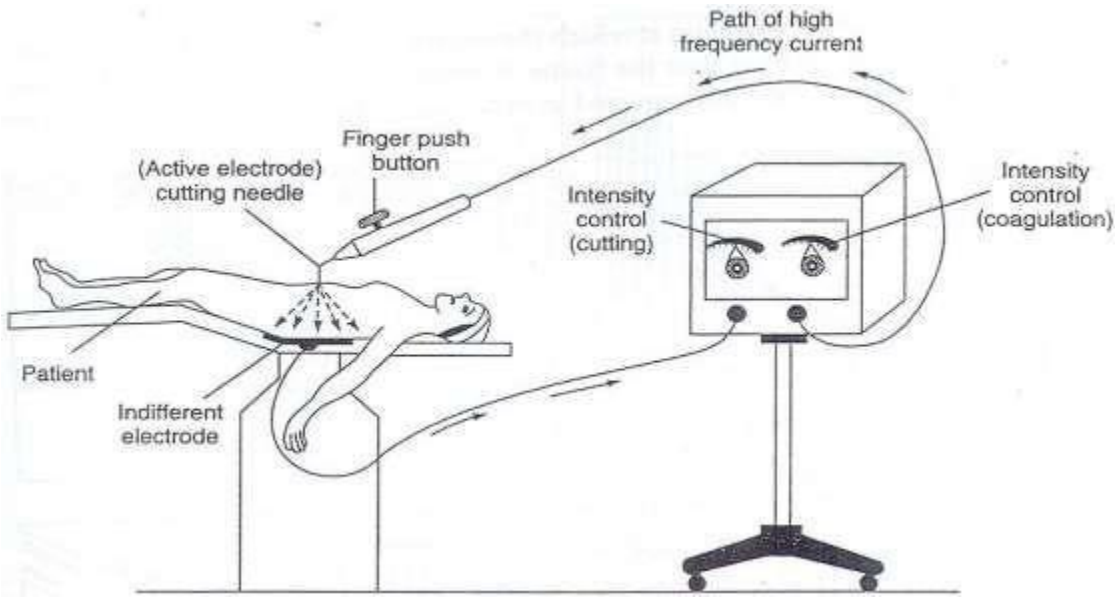


ELECTROSURGICAL UNIT:

The heart of system is the logic and control part which produce the basic signal and provides various timing signals for the cutting and coagulation modes of operation. Frequency range is from250 kHz to1 MHz .In the cutting it delivers400 W in 500 Ω load at2000 V. In the coagulation mode it delivers150 W. The output circuit in ESU is generally isolated and carefully insulated from low frequency primary and secondary voltage by means of capacitors. The block diagram shows the components of an electrosurgical unit

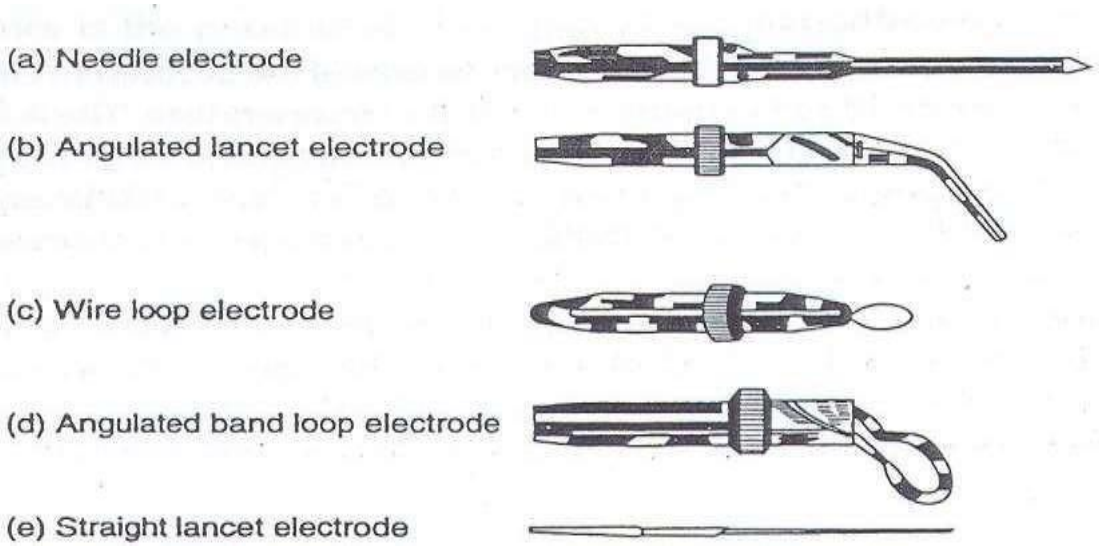


OPERATION:



ELECTRODES USED:

The image below shows the electrodes generally in ESUs



SAFETY ASPECTS:

There may be hazards due to the use of this equipment in therapy which may be such as

- Burns: caused by excess current density
- High frequency current hazard
- Explosion hazards: sparks with ether, alcohol, explosive anesthetic gas

Concerns have also been raised regarding the toxicity of surgical smoke produced by electro surgery. This has been shown to contain chemicals which may cause harm by inhalation by the patients, surgeon or operating theatre staff.

PREVENTION:

To prevent unintended burns, the skin is cleaned and a conductive gel is used to enhance the contact with the return electrode. Proper electrical grounding practices must be followed in the electrical wiring of the building. It is also recommended to use a modern Electrosurgical Unit that includes a return electrode monitoring system that continuously tests for reliableand safe patient contact. Electro surgery should only be performed by a physician who has received specific training in this field and who is familiar with the techniques used to prevent burns.

RESULT:

Thus the functions and safety aspects of the Electrosurgical Unit were studied.

VIVA QUESTIONS

1. What are the different electrodes used in ESU.
2. Why do we use electrosurgical devices?
3. What is desiccation?
4. What is fulguration?
5. What is the principle of coagulation?

EX NO: 9 RECORDING OF AUDIOGRAM

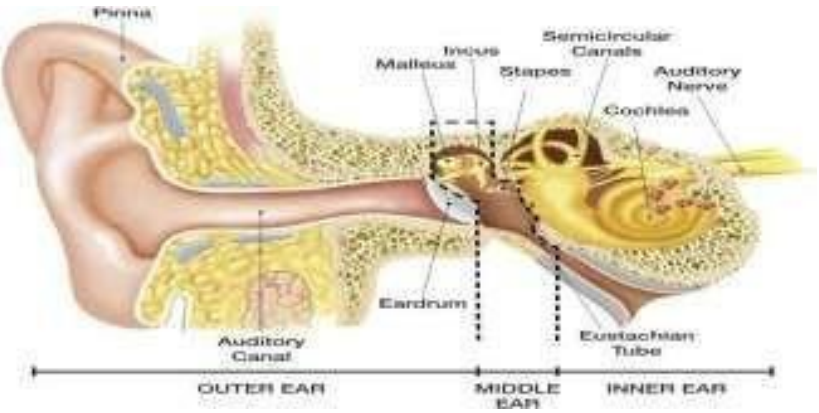
Aim: To plot audiogram of the subject using air conduction pure tone audiometer.

EQUIPMENTS REQUIRED:

- Sine wave generator 0 to 10KHz
- White noise generator
- L-R selector
- Audio Amplifier – 2Nos.
- Level Indicator Log
- Battery
- Charger

THEORY:

The human ear has three main sections, which consist of the outer ear, the middle ear, and theinner ear. Sound waves enter the outer ear and travel through the ear canal to the middle ear. The ear canal channels the waves to the eardrum, a thin, sensitive membrane stretchedtightly over the entrance to the middle ear. The waves cause the eardrum to vibrate. It passes these vibrations on to the hammer, one of three tiny bones in the ear. The hammer vibrating causes the anvil, the small bone touching the hammer, to vibrate. The anvil passesthese vibrations to the stirrup, another small bone which touches the anvil. From the stirrup, the vibrations pass into the inner ear. The stirrup touches a liquid filled sack and thevibrations travel into the cochlea, which is shaped like a shell. Inside the cochlea, there are hundreds of special cells attached to nerve fibers, which can transmit information to the brain. The brain processes the information from the ear and this distinguishes between different types of sounds.

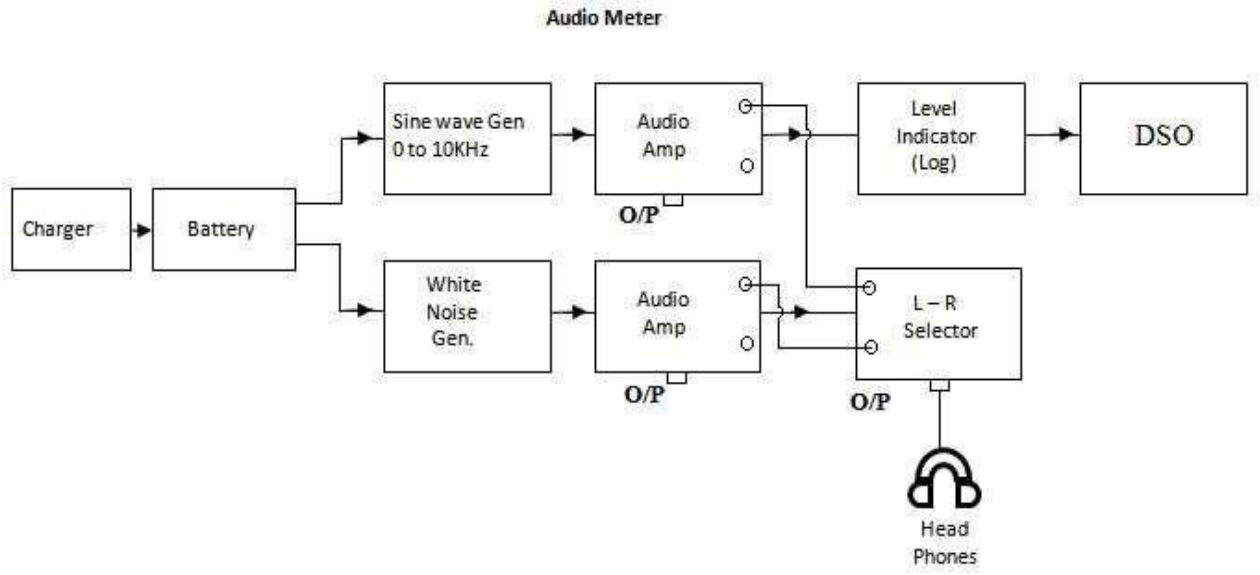


AIR AND BONE CONDUCTION:

Air conduction, by definition, is the transmission of sound through the external and middle ear to the

internal ear. Bone conduction, on the other hand, refers to the transmission of sound to the internal ear mediated by mechanical vibration of the cranial bones and soft tissues. The most important diagnostic differential from the standpoint of the functional hearing tests is the relationship between air and bone conduction acuity.

BLOCKDIAGRAM:



Sine wave generator- Sine wave generator is used to generate a sine wave in the ranger of 0-10 KHz

White noise generator- A white noise generator produces a sound that is random in character which sounds like a rushing waterfall or wind blowing through trees. White noise isa random signal with a flat power spectral density. In other words, the signal contains equal power within a fixed bandwidth at any center frequency

Audio amplifier-Audio amplifier is an electronic amplifier that amplifies low power audio signals to a required level. The audio amplifier used in this application has a frequency range of 0-10KHz

Level Indicator- The level indicator displays the level of sound in decibels it has LEDs which indicates the sound level given to the subject.

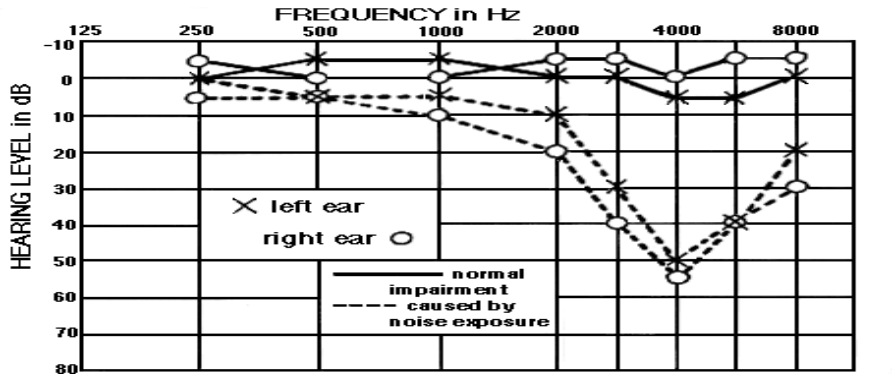
L-R selector- The L-R selector is used to select the ear in which the subject wishes todetermine the threshold of hearing.

PROCEDURE:

- Connect the modules as per the block diagram.
- Switch ON the battery.
- Adjust masking level to a suitable level so that it does not cause discomfort to the subject
- Put L, R switch in L position.

- Keeping x1, x10 switch and set frequency in steps of 100Hz. vi. Adjust output dB level till the subject hears the sound.
- Note the frequency and output dB level from DSO and level indicator respectively. viii. Repeat the above mentioned procedure for different set offrequencies.
- Put L, R switch in R position
- Repeat the above mentioned procedure for the right ear.
- Plot the graph of frequency versus output dB level for L, R.

TYPICAL AUDIOGRAM:



RESULT:

The graph of frequency verses output dB level gives audiogram of the subject

VIVA QUESTIONS

1. How does audiometry work?
2. What is audiometry used for?
3. What is Bone conduction test?
4. What can cause hearing loss?
5. What is Sensor neural hearing loss?

EX NO. 10 ORTHO PANTOMOGRAPHY (OPG)

AIM:

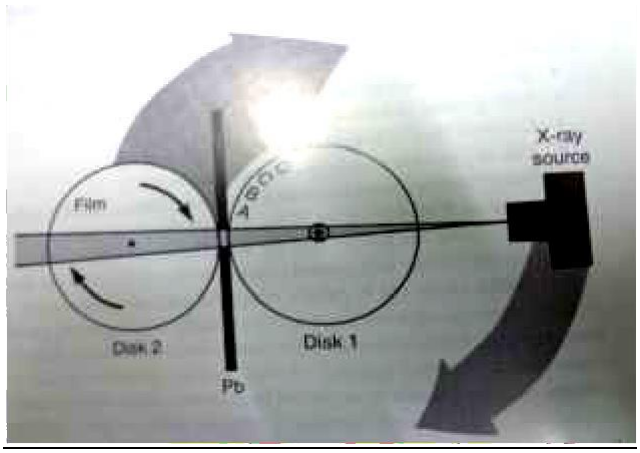
To Study the operation and working of Ortho Pantomography (OPG)

PRINCIPLES OF PANORAMIC IMAGE FORMATION

Panoramic imaging also called pantomography is a technique for producing asingle tomographic image of facial structures that includes both the maxillary andmandibular dental arches and their supporting structures.

It is based on the principle of reciprocal movement of x-ray source and an image receptor around a central point or plane called the image layer, in which the object of image is located. Object in front or behind this image are not clearly captured because of their movement relative to the centre of rotation of the receptor and the x-ray source.

The following illustration showing the operation of the panoramic machine:



Disk 1 is held stationary and the x-ray source is rotated so that central ray constantly passes through the centre of rotation of disk1 and simultaneously both disk2 and Although disk 2 moves the receptor on this disk also rotate past the slit .To obtain optimal image speed of the receptor passing the collimator slit is maintained equal to the speed at which the x-ray beam sweeps through the object of interest the leadcollimator rotate around the centre of disk 1A patient may replace disk 1 and that object A through D represent teeth and surrounding bone. Structures on the opposite side of the patient are distorted andappear out of focus.Structures near the x-ray source are so magnified.

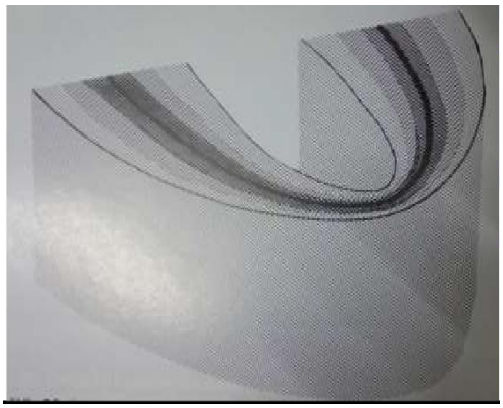
Rotation center

The pivotal point or axis around which the cassette carrier and tube head rotate is termedrotation center
Three basic rotation center used in panoramic radiography

- Double centre rotation
- Triple centre rotation

moving centre rotation The location and number of rotational centers influence size and shape of focal trough

Image layer



Also known as focal trough

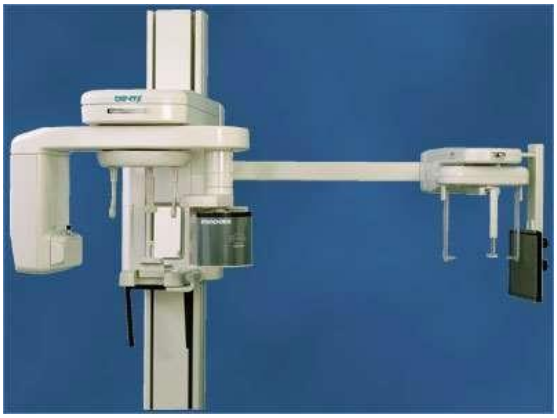
It is a three dimensional curved zone where the structures lying within this layer arereasonably well defined on final panoramic image.

The structures seen on a panoramic image are primarily those located within image layer. Objects outside the image layer are blurred magnified are reduced in size. Even distorted to the extent of not being recognizable. This shape of image layer varies with the brand of equipment used.

Factors affecting size of image layer:

- Arc path
- Velocity of receptor and X-ray tube head
- Alignment of x-ray beam
- Collimator width
- The location of image layer change with extensive machine used so recalibrationmay be necessary if consistently suboptimal images are produced.
- As a position of object is moved within the image layer size and shape of image layerchange.

Panoramic unit



PARTS OF PANORAMIC UNITS

- x-ray tube head
- exposure controls
- head positioner:
- chin rest
- notched bite block
- forehead rest

- lateral headsupport

x-ray tubehead:

Similar to intraoral x-raytube head
Eachhasa filament toproduce electrons andatarget to produce x-rays Collimatoris a lead platewith narrow vertical slit
Narrow x-raybeamemergesfromcollimatorminimizepatientexposure toradiation Tubeheadis fixedinposition androtates behind thepatient head
Film positioner is used to align the patients teeth accurately in focal trough

Exposure parameter

Power Supply	230V 50 Hz.
Kvp	50-90 KVp
Tube Current	10mA
Focal Spot	0.5mm X 0.5mm
Target Angle	5 Degree
Total Filtration	2.8 mm Al
Focus Distance	51cm
Exposure Time	19 sec
Film Size	15 X 30 cm
Weight Supply	Approx. 220 Kg.

Panoramic film

Screen film is used available in two sizes:

- 5x12 inch
- 6x12 inch

Placed between two intensifying screen in a cassette holderSensitive to light emitted from intensifying screens
When exposed to x-ray, screen convert x-ray energy into light

Intensifying screens

Two types

- Calcium tungstate –emit blue light
- Rare earth –emit green light, less x-ray exposure

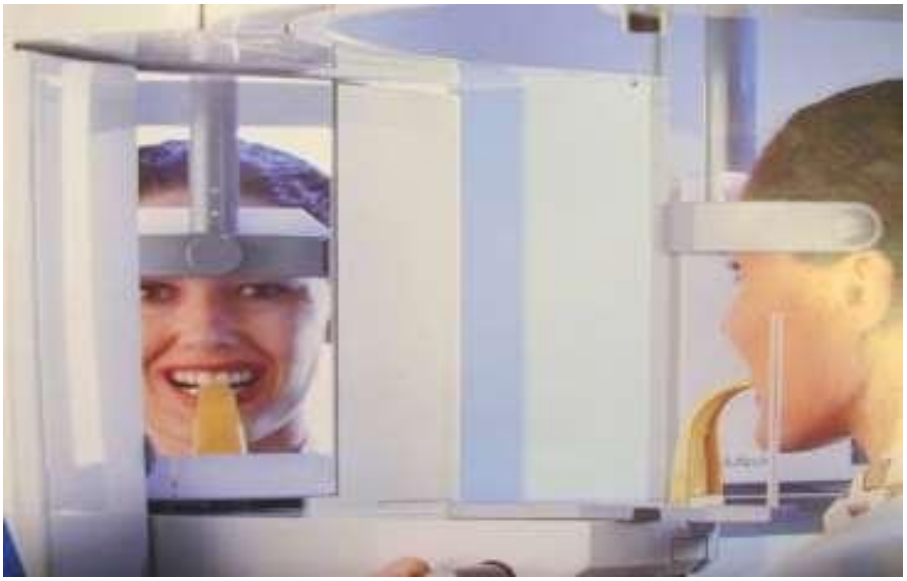
Cassette

- It is a device used to hold the extra oral film and intensifying screens
- Light tight to protect the film fromexposure

Two types

- Rigid
- Flexible

Patient positioning and head alignment

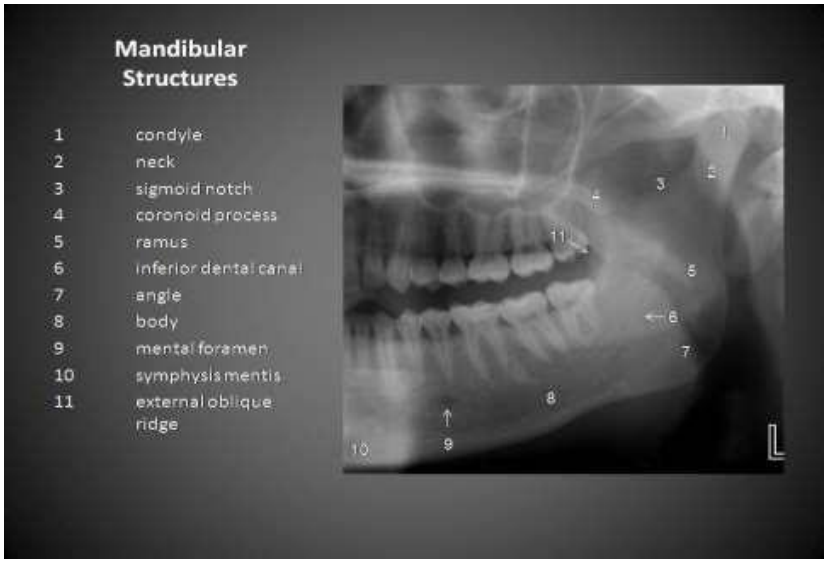


Dental appliance earrings ,necklace,hairpins,and any other metallic objects should beremoved

- Instruct the patient to stand as tall as possible with back straight and stand erect .Vertical column must bestraight
- Instruct the patient to bite on the plastic bite block tooth must be positioned in edge to edge position in the groove present in the bite block it is used to align the teeth in the focal trough
- Midsagittal plane perpendicular to floor
- Frankfort horizontal plane parallel to the floor
- Tongue must be positioned on the roof of the mouth
- Instruct the patient to remain still while machine is rotating

Interpreting panoramic image

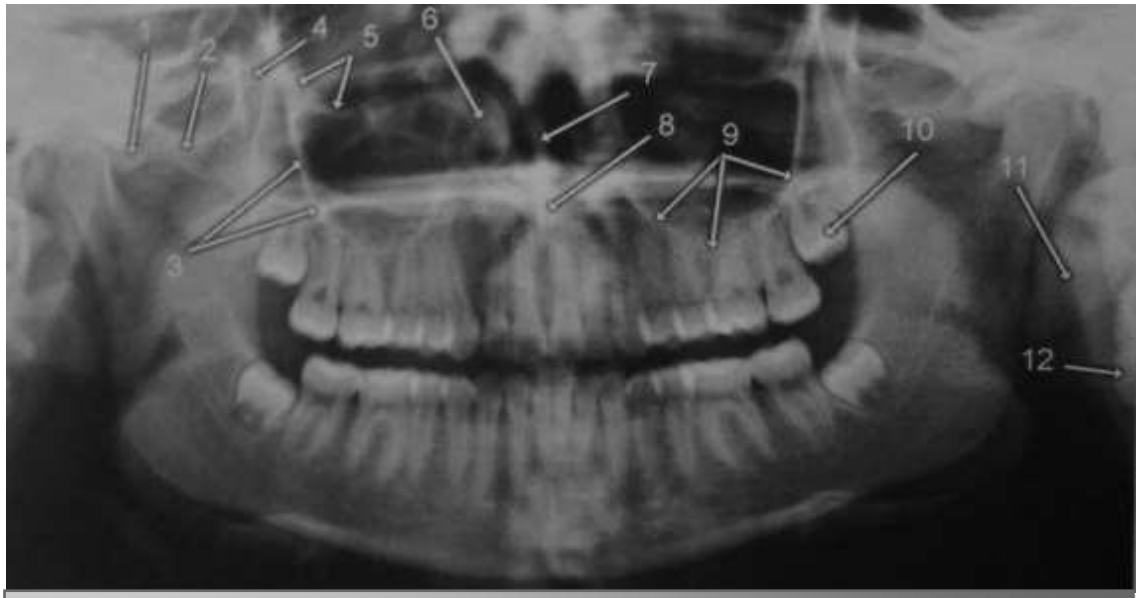
The mandible



1. Condylar process and TMJ: a bony rounded radioopaque projection extendingfrom ramus of mandible

2. Coronoid process: triangular radio opacity posterior to tuberosity region
3. Ramus: shadow of other structure may superimposed over the ramus such as
   - ❖ Pharyngeal airway shadow
   - ❖ Posterior wall of pharynx
   - ❖ Cervical vertebra
   - ❖ Ear lobe
   - ❖ Nasal cartilage
   - ❖ Soft palate anduvula
   - ❖ Dorsum of tongue
   - ❖ Ghost shadow
4. Body and angle : radiopaque bony structure where the ramus join the body ofthe mandible
5. Anterior sextant mandibular dentition and alveolus

Midfacial region

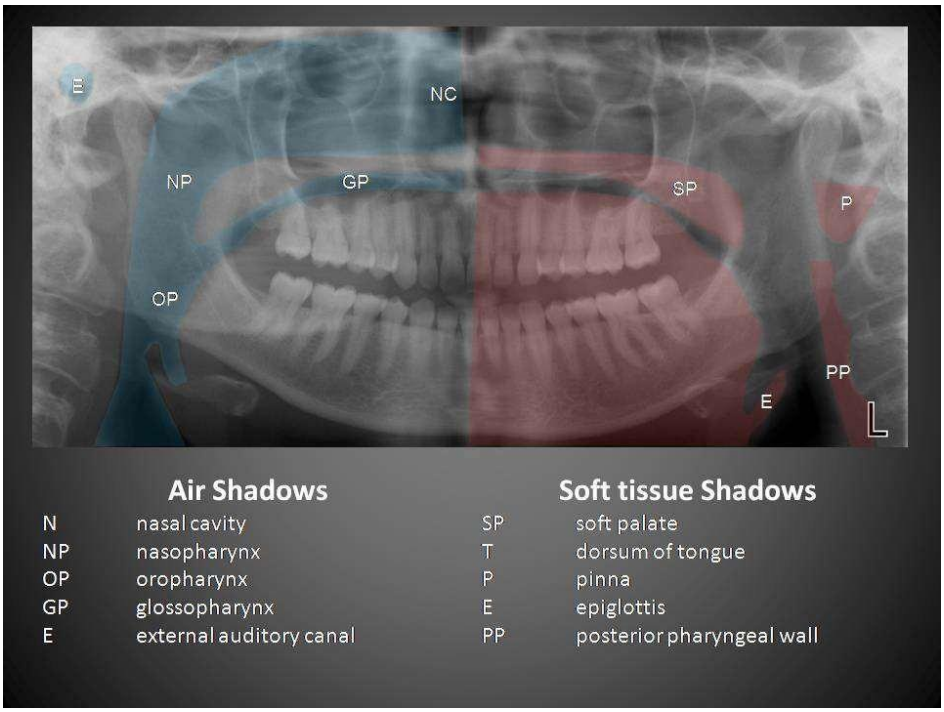


- ❖ Individual bones such as
  1. Temporal
  2. zygoma
  3. mandible

4. frontal
5. Maxilla
6. Sphenoid
7. Ethmoid
8. Vomer
9. Nasal
10. Palate

- Cortical boundary of maxilla including posterior border and alveolar ridge
- Pterygomaxillary fissure : radiolucent area between the lateral pterygoidplate and maxilla
- Maxillary sinuses: paired radiolucencies located above the apices of premolars and molars
- Zygomatic complex or buttresses of midface: includeslateral and inferior orbital rims zygomatic process of maxilla zygomatic arch
- Nasal cavity and conchae: radiolucent area above the maxillary incissors
- TMJ
- Maxillary dentition and alveolus

Soft tissues



- Tongue under the hard palate: radiopaque area superimposed over themaxillary posterior teeth
- Lip line: seen in the region of anterior teeth
- Soft palate: extending posteriorly from hardpalate
- Posterior wall of pharynx

- Nasal septum
- Ear lobes
- Nose and nasolabial fold

Dentition

Teeth and supporting alveolar boneare
evaluated Teeth examined for

- Gross anomalies of number ,position, and anatomy
- Impacted third molars
- Endodontic obturations, crowns, fixed restoration

Indication

- To evaluate impacted teeth
- To evaluate eruption patterns, growth and development
- To detect diseases ,lesions and conditions of the jaw
- To examine extent of large lesions
- To evaluate trauma periodontal bone loss and periapicalinvolvement.
- Finding the source of dental pain
- Assessment for the placement of dentalimplants
- Orthodontic assessment. pre and postoperative
- Caries detection especially in the inter-dental region.
- Diagnosis of developmental anomalies such as Cherubism, Cleido cranial dysplasia
- Carcinoma in relation to the jaws
- Tempero mandibular joint dysfunctions andankylosis

Advantages

- Broad coverage of facial bones and teeth
- Low patient radiation dose
- Convenience of the examination of the patient
- Use in patients unable to open theirmouth
- Short time required
- In patient education and case presentation

Disadvantage

- Image quality are not sharp
- Focal trough limitations
- Distortion
- Expensive equipment cost

Conclusion

As OPG has several advantages in the field of dentistry and its inevitable role in diagnosis every dentist should know about it.

Compared with the conventional radiographic technique involving atleast 16 intraoral exposures OPG has several advantage it takes fairly easy; takes one minute and shows entire oral cavity in one minute however resulting image produce less detail than IOPA

Result :

Thus the OPG - Orthopantomograghy is studied.

Ex.No 11: ELECTRICAL SAFETY MEASUREMENTS

Aim:

To study the Electrical Safety Measurements in operation theatre.

If the electron flow or current flow is always in the same direction, it is referred to as direct current (DC). In this case the electrons travel from the negative terminal of the battery, through the amp meter and light bulb (or other load) and return to the battery through the positive terminal. By contrast, the "conventional current" is said to go in the opposite direction, from the positive terminal of the battery to the negative terminal of the battery

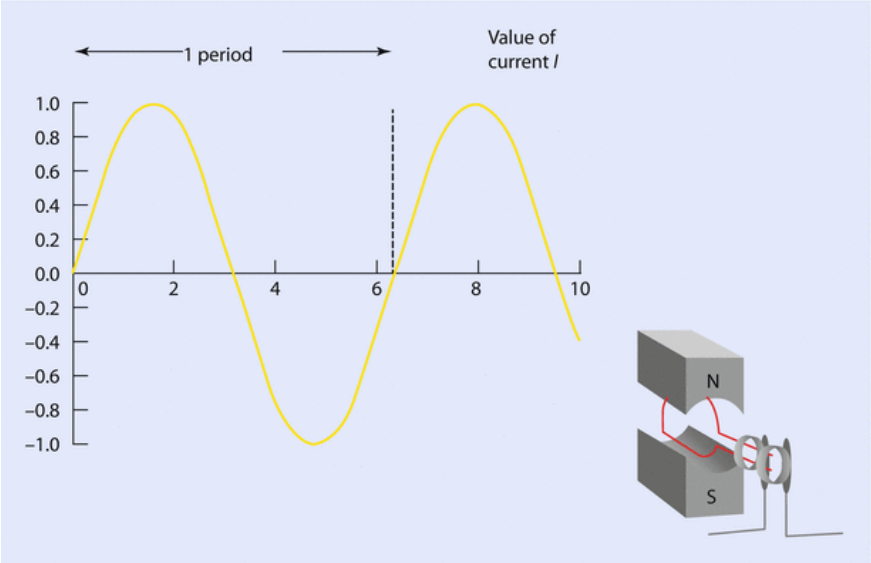


Fig. 1

Alternating current usually takes on a sinusoidal form, often the result of a wire assembly rotating past a magnet assembly (note the north and south poles) as illustrated schematically on the lower right. The alternating current from the wall that we use every day in North America completes 60 cycles per second (60 Hz); in Europe the frequency is50 Hz. The voltage supplied is usually 120 volts (usually 220 volts in Europe).

Electrical Resistance

Some materials are not perfect conductors of electricity; that is, they display electrical resistance. In fact, one can think of a conductor as a material having very low (ideally zero) resistance while insulators can be thought of having very high (ideally infinite) resistance to the flow of electrons. The current that passes through an electrical resistor when a voltage difference is applied across it is given by Ohm's law

$$V = I \times R$$

Where

- V is the electromotive force (in volts)
- I is current (in amperes)
- R is resistance (in ohms)

Example 1: What resistance across a 100 volt source would produce a current of 100 ma (= 0.1 amp)?

Answer: From Ohm's law, R = V/I = 100 volts/0.1 amp = 1000 ohms.

Example 2: If a 200 volt pulse from a nerve stimulator results in a current flow of 50 ma,what is the skin resistance?

Answer: From Ohm's law, R = V/I = 200 volts/0.05 amp = 4000 ohms.

Note that Ohm's law (V = I × R) is analogous to the physiologic equation describingsystemic

$$(MAP - RAP) = CO \times SVR$$

blood pressure:

That is, the difference between the mean blood pressure and the right atrial pressure is equal to the cardiac output (CO) times the systemic vascular resistance (SVR), where SVR is in Woods units. Finally, to convert vascular resistance in Woods units to the morecommonly used dyn s cm^{-5} units, multiply by 80:

$$SVR = [(MAP - RAP)/CO] \times 80 \left(\text{dyn s cm}^{-5}\right)$$

Electrical Power

The electrical power (W) consumed by an electrical device is measured in watts:

$$W = V \times I$$

Where V is the voltage applied to the device and I is the electrical current that passesthrough the device.
Example 1: What is the power consumed by a patient warmer that draws 10 ampereswhen plugged into a 110 volt source?
Answer: From W = V × I, the power consumed is 110 volts × 10 amperes = 1100 watts.

Example 2: If a 200 volt pulse from a nerve stimulator results in a current flow of 50 ma,what is the power delivered to the patient?
Answer: From W = V × I, the power delivered is 200 volts × 0.05 amp = 10 watts.

Electrical Energy

The watt-second (or joule, J) is commonly used to denote electrical energy expended in doing work. The energy produced by a cardiac defibrillator is measured in watt-seconds (or joules), while the kilowatt-hour is frequently used to measure larger quantities of electrical energy. As an example, electrical utility companies charge their customers on the basis of kilowatt-hours of electricity consumed. The formula to use here is:

$$J = W \times T$$

where W is the power consumed in watts and T is the time in seconds over which the power is consumed. Note that a kilowatt hour (kWh) is equivalent to 3,600,000 watt- seconds or joules.

Example 1: What is the energy consumed by a 100 W fluid warmer when operated for 1 h?
Answer: From J = W × T, the energy consumed is 100 W × 60 min × 60 s/min = 360,000 J.

Example 2: What is the answer to Example 2 in kilowatt-hours?
Answer: The power consumed is 0.1 kW × 1 h = 0.1 kWh.

Capacitance

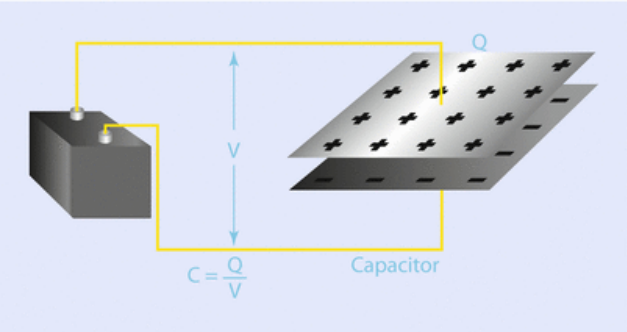
A capacitor consists of any 2 conductors (such as parallel plates) that are separated by an insulator. A capacitor stores charge (electrons). In a DC circuit the capacitor plates are charged by a voltage source (ie, a battery) and there is only a momentary current flow as the capacitor charges. No further current can then flow unless a resistance is connected between the 2 plates and the capacitor is subsequently discharged. In contrast to DC circuits, a capacitor in an AC circuit permits current flow, depending on the impedance presented by the capacitor at a given frequency of alternating current.
Figs. Capacitors are a key component in the design of cardiac defibrillators where they serve as an energy storage device according to the formula:

$$E = \frac{1}{2} C V^2$$

where E is the energy in joules (J), C is the capacitance in farads, and V is the voltage in volts. For example, if the capacitance of the capacitor is 1000 μF (microfarad) and the voltage applied to it is 1000 V then the stored energy is 500 J based on the following calculation:

$$E = \tfrac{1}{2}\ C\ V^2 = \tfrac{1}{2}\ \left(1000 \times 10^{-6}\right)\left(1000^2\right) = 500\ J$$

0Figure above



A capacitor consists of any 2 conductors (such as parallel plates) that are separated by an insulator.
A capacitor stores charge (electrons)

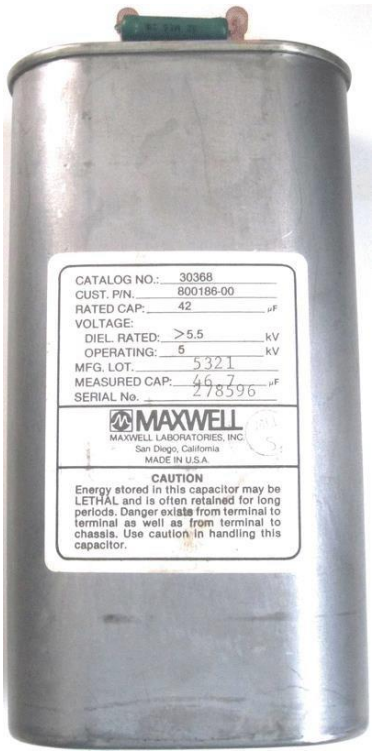


Figure above A high-energy capacitor used on a cardiac defibrillator. The capacitor is rated 42 microfarad at 5000 volts. Using the formula $E = ½\ C\ V^2$ the energy stored in the capacitorbecomes = $½\ (42 \times 10^{-6})(5000^2)$ = 525 J Note that the energy delivered during an initial monophasic defibrillation is usually 200 J,with less energy typically used for biphasic defibrillation.

Electrical Shock Hazards

Stimulation with electricity can cause muscle cells to contract, and can thus be used therapeutically in equipment such as pacemakers or defibrillators or diagnostically whena nerve stimulator is used to assess the degree of neuromuscular blockade. However, contact with a large electrical voltage (such as a power line), whether AC or DC, can lead to injury or even death, often as a result of ventricular fibrillation. It takes approximately3 times as much DC current as AC current to cause ventricular fibrillation.

Figure below illustrates a typical AC electrical power arrangement in schematic form. A typical electrical outlet consists of 2 wires (“hot” and “neutral”) in conjunction with a third “ground” connection as in figure. The wire designated as “hot” carries the current to the load while the other (“neutral”) wire returns the current

to the source. The potential difference between the 2 is typically 110 and 120 volts. To receive an electrical shock, one must be in contact with the electrical circuit at 2 points, and there must be a voltage supply that causes current to flow through an individual.

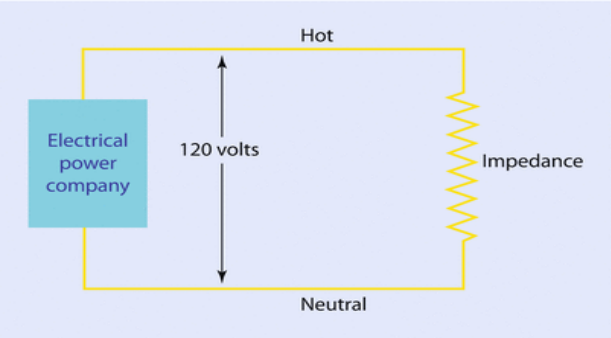
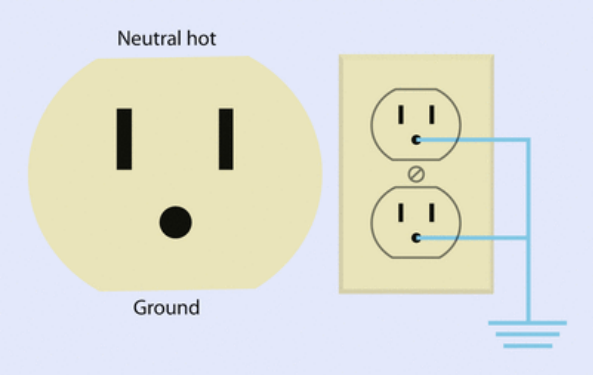


Figure above
Schematic illustration of a typical AC electrical power arrangement



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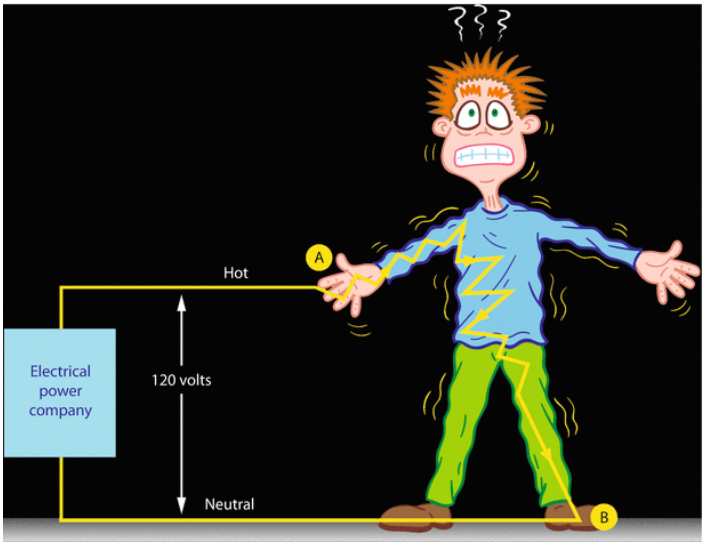


Figure above
To receive an electrical shock, one must be in contact with an active electrical circuit at 2 points.
When an electrical shock occurs, damage can occur in 1 of 2 ways. In the first mechanism, the electrical

current can disrupt the normal physiological function of cells. Depending on its magnitude and path, the current can contract muscles, paralyze respiration, or lead to cardiac arrest via ventricular fibrillation. The second mechanism involves the dissipation of electrical energy throughout the body's tissues: An electrical current passing through any resistance raises the temperature of that substance, sometimessufficiently to produce a burn. Basically, the electricity cooks the tissue it passes through. Table .summarizes the physiological effects of various currents passing through the body for a 1-second duration.

Physiological effects of various degrees of electrical current

Electric Current (1 second contact)	**Physiological effect**
20 μA	Can possibly cause ventricular fibrillation in a "microshock" setting
1–5 mA	Threshold of feeling, tingling sensation.
10–20 mA	"Can't let go!" current – Onset of sustained muscular contraction.
100–300 mA	Ventricular fibrillation in "macroshock" setting

The severity of an electrical shock is determined by the amount of current (amperes), its path through the body, and the duration of the current flow. For the purposes of this discussion, it is helpful to divide electrical shocks into 2 categories. Macroshock refers to large amounts of current flowing through a person, which can cause harm ordeath. Microshock refers to very small amounts of current (in the microampere and milliampere range) and applies only to the electrically susceptible patient, such as an individual who has an external conduit that is in direct contact with the heart. This can be a pacing wire or a saline-filled catheter such as a central venous or pulmonary artery catheter. In the case of an electrically susceptible patient, even minute amounts of current (microshock) may cause ventricular fibrillation.

In the electrically susceptible patient, ventricular fibrillation can be produced by a current that is below the threshold of human perception. The exact amount of current necessary tocause ventricular fibrillation in this type of patient is unknown (the experiments would be unethical), but based on animal experiments is believed to be as little as 20 μA.

Grounding

Figure below Ground connections on electrical plugs are used to help prevent electric shocks. An electrical shock may occur when an individual gets connected between the hotand neutral connections in a circuit, either directly as shown in figure, or via a frayed wirethat has resulted in a short circuit producing a "hot case," as illustrated in next figure.

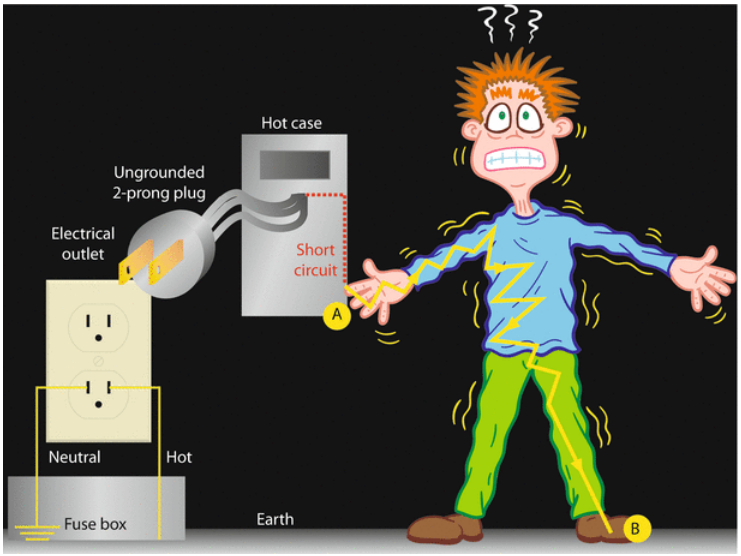


Figure above

In the absence of an electrical grounding system, a frayed wire or other problem may result in a short circuit, producing a “hot case” that could electrocute anyone who touchesit. Figure. Note, however, that if a 3-pronged plug is employed so that the case isgrounded, any short circuit current from a frayed wire or similar problem will safely return any current to the ground instead of travelling through the victim. This is illustratedin ◘36.9.

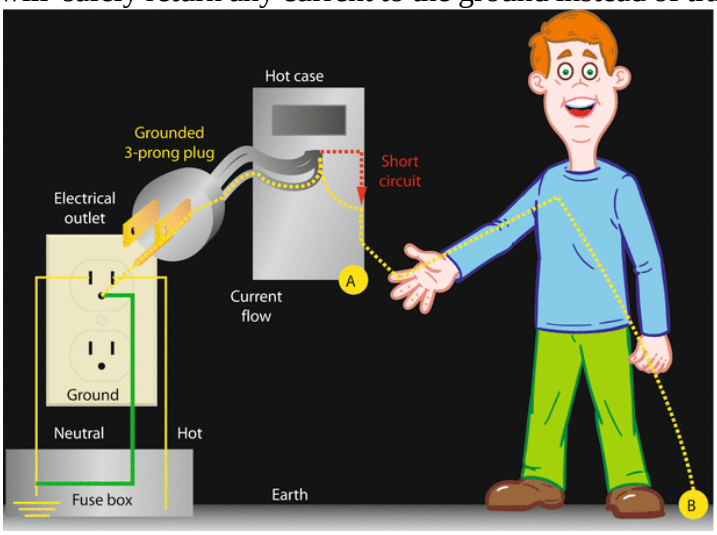
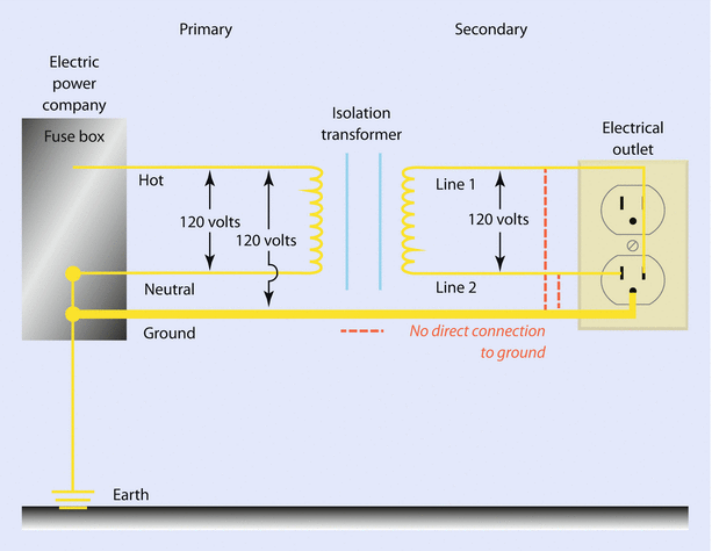


Figure above

When an electrical grounding system is used, any frayed wire that would ordinarily result in a short circuit and a “hot case” instead results in electricity passing through the ground wire rather than through anyone who might be in contact with the “hot case”.

The Line Isolation Monitor

Isolated power systems are frequently used in operarting rooms. Such systems use an isolation transformer Figures system so that neither of the 2 output lines powering the operating room equipment offers any voltage with respect to ground. This helps eliminatethe shock hazard associated with working in wet environments such as the operating room.



Figure

Isolated power systems are frequently used in operating rooms. Such systems use an isolation transformer system so that neither of the 2 output lines powering the operating room equipment offers any voltage with respect to ground.

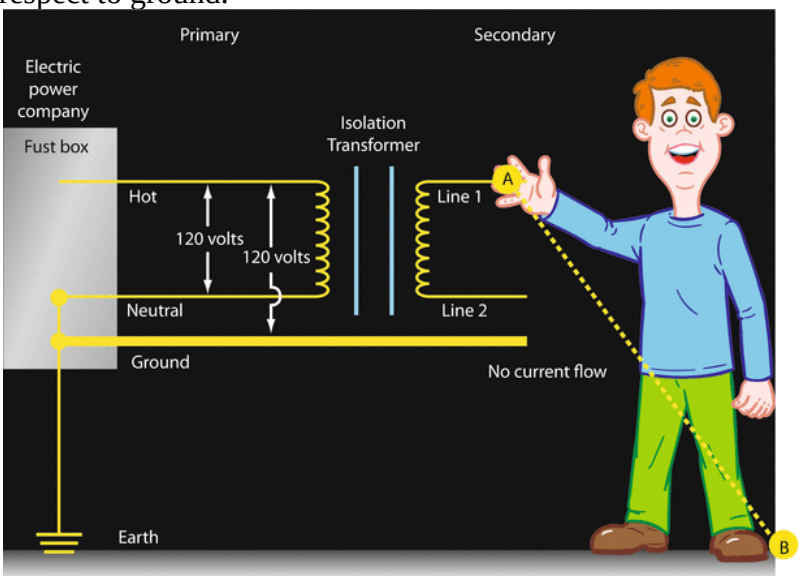


Figure above

When an isolated electrical power systems is used, since neither of the 2 output lines offers any voltage difference with respect to ground, no shock hazard is offered to anyonewho comes into contact with either one of the 2 outputs of the isolation transformer.

RESULT: Thus the Electrical Safety Measurements in operation theatre is studied**.**

EX.NO:12 EEG WAVE ANALYSIS USING SIMULATOR

AIM:

To measure and record the amplitude and time taken for the different alpha , theta,beta and gamma EEG waves.

APPARATUS REQUIRED:

1. EEG stimulator
2. Connecting probes
3. Biokit physiograph
4. PC

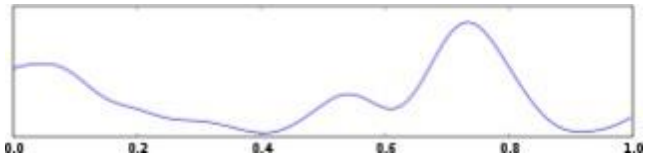
THEORY:

Electroencephalography (EEG) is the recording of electrical activity along the scalp produced by the firing of neurons within the brain. In conventional scalp EEG, the recording is obtained by placing electrodes on the scalp with a conductive gel or paste. Electrode locations and names are specified by the International 10−20 system for most clinical and research applications. Each electrode is connected to one inputof a differential amplifier (one amplifier per pair of electrodes); a common system reference electrode is connected to the other input of each differential amplifier. These amplifiers amplify the voltage between the active electrode and the reference.

A typical adult human EEG signal is about 10μV to 100 μV in amplitude when measured from the scalp and is about 10−20 mV when measured fromsubdural electrodes.

EEG WAVE PATTERNS:

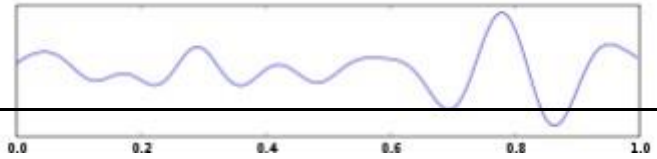
DELTA WAVE:



Delta is the frequency range up to 4 Hz. It tends to be the highest in amplitude and the slowest waves. It is seen normally in adults in slow wave sleep. It is also seen normally in babies.

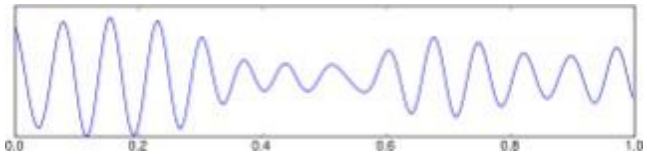
THETA WAVE:

Theta is the frequency range from 4 Hz to 7 Hz. Theta is seen normally in young children. It may be seen in drowsiness or arousal in older children and adults; it can alsobe seen in meditation.



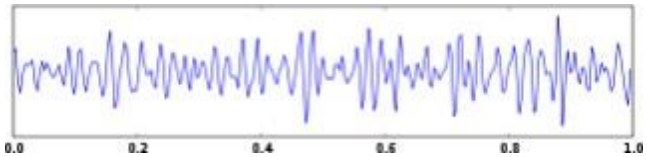
ALPHA WAVES:

Alpha is the frequency range from 8 Hz to 12 Hz. Hans Berger named the first rhythmic EEG activity he saw, the "alpha wave. It emerges with closing of the eyesand with relaxation, and attenuates with eye opening or mental exertion. The posterior basic rhythm is actually slower than 8 Hz in young children.



BETA WAVES:

Beta is the frequency range from 12 Hz to about 30 Hz Beta activity is closely linkedto motor behaviour and is generally attenuated during active movements. It is the dominant rhythm in patients who are alert or anxious or who have their eyes open.



Since an EEG voltage signal represents a difference between the voltages at two electrodes, the display of the EEG for the reading encephalograph may be set up in one of several ways. The representation of the EEG channels is referred to as a *montage*.

BIPOLAR MONTAGE:

Each channel (i.e., waveform) represents the difference between two adjacent electrodes. The entire montage consists of a series of these channels. For example, the channel "Fp1-F3" represents the difference in voltage between the Fp1 electrode and the F3 electrode. The next channel in the montage, "F3-C3," represents the voltage difference between F3 and C3, and so on through the entire array of electrodes.

REFERENTIAL MONTAGE:

Each channel represents the difference between a certain electrode and a designated reference electrode. There is no standard position for this reference; it is, however, at a different position than the "recording" electrodes. Midline positions are often used because they do not amplify the signal in one hemisphere vs. the other. Another popular reference is "linked ears," which is a physical or mathematical average of electrodes attached to both earlobes and mastoids.

AVERAGE REFERNTIAL MONTAGE:

The outputs of all of the amplifiers are summed and averaged, and this averaged signal isused as the

common reference for each channel.

LAPLACIAN MONTAGE:

Each channel represents the difference between an electrode and a weighted average of the surrounding electrode.

When analog (paper) EEGs are used, the technologist switches between montages during the recording in order to highlight or better characterize certain features of the EEG. With digital EEG, all signals are typically digitized and stored in a particular (usually referential) montage.

TABULAR COLUMN:

WAVES	AMPLITUDE(V)	TIME(S)	FREQUENCY(Hz)	POWER
ALPHA				
BETA				
THETA				
DELTA				

PROCEDURE:

1. From the EEG stimulator input is given to the biokit physiograph.
2. The physiograph kit is connected to the PC using RS232.
3. For the respective alpha, beta, theta and delta waves the amplitude and time are noted.
4. The FFT is performed for the respective waves and the values are noted.

RESULT:

Thus the EEG waves are studied and the amplitude and time for each waveforms arenoted for a subject.

EX.NO:13 -MEASUREMENT OF DRUG DELIVERY SYSTEM BYUSING SYRINGE PUMP

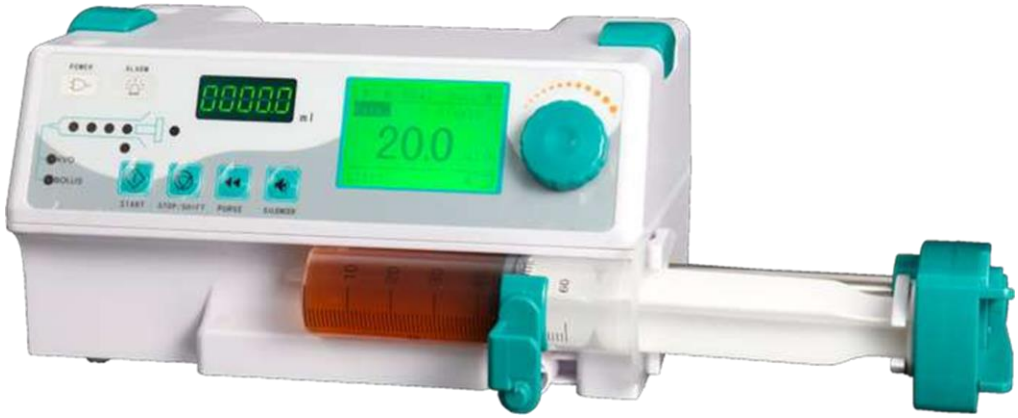
AIM

To measure the drug delivery to the patient by using syringe pump.

APPARATUS REQUIRED:

Drug delivery system by syringe pump, monitor and syringe size as required by thepatient.

FEATURES



- Audible and visual alarm for occlusion, empty, near empty, low battery, end ofinfusion, syringe loose, wrong setting etc, which gains patents
- HD LCD Display, high capacity words, friendly user interface, dynamicallydisplay working status
- Compatible with 10ml, 20ml, 30ml, 50ml syringe of any brands
- Preset Solution Volume to greatly reduce the workload of nurses
- Three work modes: Rate mode, Time Volume mode, Dosage Weight mode
- Three levels of occlusion: high, middle and low
- Purge and Bolus function
- KVO: KVO (keep-vein-open) automatically opens as infusion is completed
- Freely Stackable: freely stack one onto another to provide multiple Solutions,which have a wide range of clinical applications.
- Automatically record the settings for last injection
- Power Source: AC100-240V, 50/60Hz; Internal Battery, DC12V car charge
- One-key operation makes setup easy and simple
- Syringe Plunger Grabble Detector, operable with one hand in a No-GermEnvironment
- Syringe brand can be displayed, furthermore, syringe specification can be writteninto the

pump

- language: English, Poland, Latvian, Russian etc

TECHNICAL SPECIFICATION INJECTION SPEED

- 50(60)ml Syringe 0.1ml/h—999.9ml/h (0.1ml/h step)
- 1000ml/h—1500ml/h (1ml/h step)
- 30ml Syringe 0.1ml/h—900ml/h (0.1ml/h step)
- 20ml Syringe 0.1ml/h—600ml/h (0.1ml/h step)
- 10mlsyringe 0.1ml/h—300ml/h (0.1ml/h step)

PURGE RATE

- 50(60)ml Syringe: 1500ml/h
- 30ml Syringe: 900ml/h
- 20ml Syringe: 600ml/h
- 10ml Syringe: 300ml/h

MECHANICAL ACCURACY

- within±2% RATE

ACCURACY

- within±3% (after correct calibration)BOLUS

RATE

- 50(60)ml Syringe: 1200ml/h
- 30ml Syringe: 720ml/h
- 20ml Syringe: 480ml/h
- 10ml Syringe: 240ml/h

OCCLUSION

- High 800mmHg±200mmHg(106.7kPa±26.7kPa)
- Medium 500mmHg±100mmHg(66.7kPa±13.3kPa)
- Low 300mmHg±100mmHg(40.7kPa±13.3kPa)TOTAL

INJECTION

- 0.1ml—9999.9ml (0.1ml step)

VOLUME LIMIT

- 0.1ml—999.9ml (0.1ml step)ALARMS
- Injection soon finish end of injection occlusion improperly
- Installation of syringe wrong setting low battery etcPOWER

SOURCE

- 100V—240V 50/60Hz Internal rechargeable Li battery volume≥1,600mAh 4hours internal battery backup; DC 12V

KVO SPEED

- 1ml/h

POWER CONSUMPTION

- 18VA

OPERATION ENVIRONMENT

a) Temperature +5—+40degree

b) Humidity 20—90%

c) Atmospheric Pressure 86.0KPa—106.0KPaSTORAGE

a) Temperature -30—+55degree

b) Humidity ≤95%

c) Atmospheric Pressure 50.10KPa—106.0KPa

DIMENSION

- 280mm(L)x 210mm(W)x 130mm(H)WEIGHT
- 2.2KGSYRINGE
- Compatible with any brandPACKAGE
- 1pc for each Carton, 3.2KG; 35cm (L) × 28cm (W) × 17cm (H)
- 2pc carton,6.6KG; 40cm (L) × 39cm (W) × 32cm (H)
- 3pc carton, 10KG; 59cm (L) × 39cm (W) × 32cm (H)

SYRINGE PUMP

Syringe pumps are particularly helpful under such circumstances as they areprogrammed to do deliver drug through the vein at a determined rate.

WORKING OF SYRINGE PUMP

- Syringe pump generally consist of a drum that is attached to a piston.
- The piston is operated by a motor through a drive screw or worm gear which helps in pushing the plunger of syringe in or out resulting in a smoothflow.
- The syringe is engaged on a clamp on the frame and the plunger of the syringe is displaced by movement of drum.
- Most of the syringe pump can work with different syringes of different diameters, but the diameter has to be entered in beginning to make sure correct volume is dispensed.

- These guidelines should be read from manufacturer guidelines, and made sure whether syringes with different diameter can be used.

The user can set the parameters such as flow rate, dispense volume and syringe diameter.

SYRINGE PUMP

RESULT:

Thus Measurement of drug delivery system by using syringe pump is studied and verified.

EX.NO: 14 MEASUREMENT OF DRUG DELIVERY SYSTEM BY USING INFUSION PUMP

AIM:

To study and verify the Measurement of drug delivery system by using Infusion pump

APPARATUS REQUIRED

The infusion pump and the drug required for administration

INTRODUCTION

There are various types of infusion pump designed with a view to serve different purpose of therapy but it is important that the pumps selected can deliver the fluids at desired rate and volume

DEFINITION

Infusion pumps are devices that are used to deliver therapeutic fluids which can be eithermedication or nutrients at a predetermined rate

PRINCIPLE

It use pumping action to infuse fluids, medication or nutrients into patient. It is suitable for intravenous, subcutaneous, enteral and epidural infusions

USES OF INFUSION PUMP

- Chemotherapy
- Pain management
- Total parental nutrition
- Anesthesia/sedation

TYPES OF INFUSION PUMPS

There are two basic types of infusion pump

- Syringe Pumps
- Volumetric Pump

VOLUMETRIC PUMP

VOLUMETRIC PUMPS

- The pump has an advantage to deliver high volume of fluid at precise administered rate where other pumps might have limited or no use at all.

WORKING OF VOLUMETRIC PUMPS

- Volumetric pumps are designed for and suited to delivery of larger volumes of fluid at medium to high flow rates. Almost all volumetric pumps are accurate to well within the specified ±5% when measured over one hour.
- It is used to accurately deliver intravascular drugs, fluids, whole blood, and blood products to the patient. A linear peristaltic or piston cassette pump insert is utilized to control the prescribed infusion volume.
- They use computer-controlled rollers compressing a silicone which the medicine flows.

MAINTAINANCE OF PUMPS

- Always place pump and supplies on a clean surface.
- Keep food and drinks away from the area around the pump.
- Monitor children when in the pump area.
- Before touching the pump

- wash hands
- dry with a clean paper towel
- change tubing according to pump's instructions
- change batteries or recharge the pump as directed by healthcareprovider.
- Surroundings

Radio transmitters (such as cell phones, wireless hand-held computers, two way radios are sources of strong electric and magnetic interference (EMI), such as large electric motors, could affect pump– Pump users, care givers, and others should use caution and keep electromagnetic sources away from the pump.

RESULTS:

Thus Measurement of drug delivery system by using infusion pump was studied and verified.