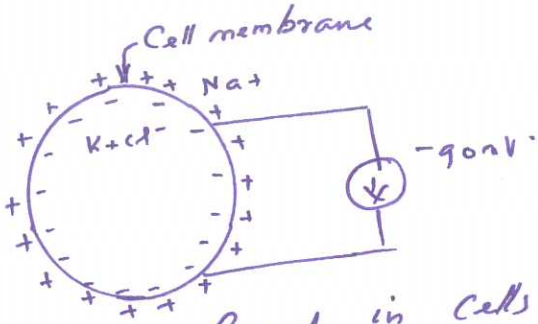
Scheme of Evaluation
Medical Electronics.

TED(15) 5044
Revision 2015

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| I | 1. | The fundamental unit of the body is the cell and a group of similar cells constitute a tissue, A group of tissue form an organ, different organs desired to perform a particular function is a system. Different systems combined together form a human body [Cells – Tissues → Organs → System – Human body] | 2 |
| | 2. | The minimum pressure occuring at the end of the ventricular relaxation is called diastolic pressure | 2 |
| | 3. | Pressure cycled Ventilator<br>Volume Cycled Ventilator<br>Servo Controlled Ventilator | 2 |
| | 4 | → Measurement of Haematocrit / Mean Cell volume by Centrifugal Sedimentation.<br>→ Microscopic method<br>→ Automatic optical method (Dark field method)<br>→ Coulter Blood Cell Counter Electrical Conductivity method) | 2 |
| | 5 | 1. Radio frequency transmission for monitoring the health of astronauts in space<br>2. Patient monitoring in an ambulance and in other Locations away from the hospital<br>3. Collection of medical data from a home or office<br>4. Use of Telephone link for transmission of ECG's or other medical data | 2 |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| | | PART-B | |
| II | 1. | Hemopoietic System - It Consist of blood in which there are cellular elements and fluid Plasma<br>The plasma Contains<br>- Absorbed food Stuffs<br>- Metabolic products<br>- Enzymes<br>→ Hormones and other substances<br>The Cellular elements Consist of<br>→ RBC (Red Blood Corpuscles or Erythrocytes)<br>→ WBC (White Blood Corpuscles or Leukocytes)<br>→ Blood Platelets or Thrombocytes | 6 |
| | 2 |  <br>⇒ Ionic potentials are formed in cells of the body due to the differences in the Concentration of Certain Chemical ions, like Sodium $Na^+$, $Cl^-$ and $K^+$ ions.<br>⇒ The Cell wall is a Semi permeable membrane, having ability to pass certain ions | |

| Question No. | Scoring Indicator | Marks |
|---|---|---|
| | ⇒ At rest the cell membranes are more permiable to some ions like $K^+$, and $Cl^-$ and less permiable to some ions like $Na^+$. As a result the Concentration of +ve $Na^+$ ions inside a cell is less than the Concentration of Sodium ions outside the cell.<br>⇒ A phenomenon known as the Sodium Pottasium pump Keeps the Sodium Largly outside the cell and potassium ions inside<br>⇒ This remls in a difference of Ion Concentration Creating an electrical potential and this causes the cell to be polarized<br>⇒ The difference in potential between the outside and inside of the cell is called Resting Potential<br>{fig-3, Explanat 3<br>3 + 3 = 6} | 6<br>(3+3) |
| 3. | → Monochromaticity<br>→ Spatial and temporal coherence<br>→ Directionality<br>→ Brightness.<br>→ Can be oparated in Continuous mode or pulsed mode<br>→ Variable Wavelengths from UV to IR range<br>(1 x 6) | 6. |

| Question No. | Scoring Indicator | Marks |
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| 4 | → For the treatment of cardiac rhythm disorders<br>→ For the treatment of Brady arrhythmias and tachy arrhythmias<br>→ In any pathological abnormalities in SA node, AV node and His Purkinje system.<br>⇒ In the case of heart block like AV node block and left bundle branch block<br>Pacemaker is a device which produce electrical impulses given to the heart muscles for stimulating and their by regulate the heart rate. | 6. |
| 5. | → The Subjects body becomes a part of the electrical circuit and the heat is produced with in the body and not transferred through skin.<br>→ Treatment can be controlled precisely.<br>→ Carefull placement of electrodes permits localization of the heat to the region that has to be treated<br>→ The amount of heat can be closely adjusted<br>→ No discomfort is caused to the Subject<br>→ The Current being alternating, it is possible to pass through the tissues currents of a much greater intensity to produce direct heating in the tissues similar to any other electrical Conductor<br>→ RF energy used to treats the tissues and promotes healing of injured tissues and inflammations. | 6. |

| Question No. | Scoring Indicator | Marks |
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6. → Speed $3 \times 10^{10}$ cm/s
→ Unaffected by electric and magnetic fields.
→ X-rays are able to penetrate through the materials which readily absorb and reflect visible light, because of short wavelength and extremely high energy
→ X-rays are absorbed while passing through the matter and produce secondary radiation.
→ X-ray produce ionisation in gases and influence the electrical properties of liquids and solids.
→ X-ray produce fluorescence in certain materials to emit light.
→ X-ray affect photographic film in the same way as ordinary visible light.

(Any six points. 1 × 6) — 6

7

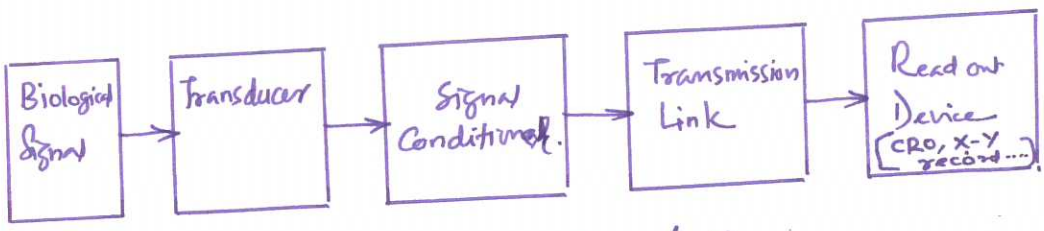


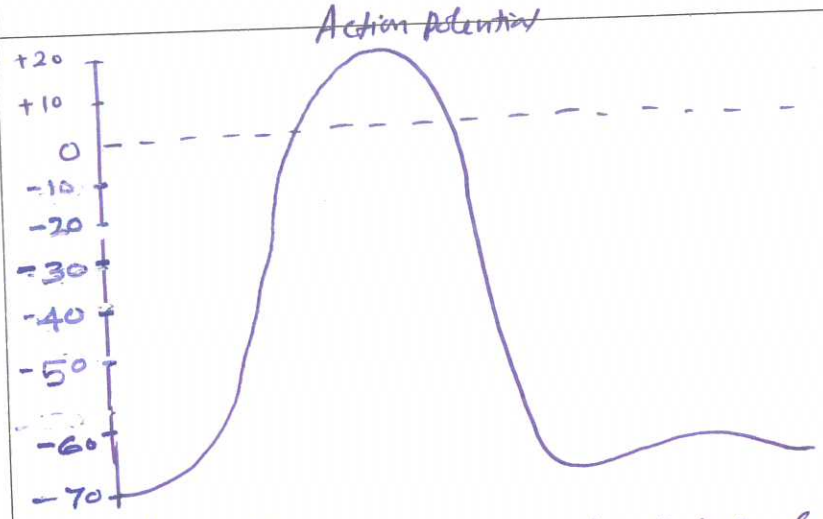

Fig-3 Expt-3

6

⇒ Electrodes which are connected to the patient pickup, the biological signals like ECG, EEG, EMG..etc from body.
⇒ Transducer convert the biological variable into electric signal
⇒ Signal Conditioner Consist of Amplifier, & filter, that Amplify and modify signal for effective transmission
⇒ Transmission link Consist of FM Transmitter which transmits or Connects to input blocks to the read out device by wire or wireless.
⇒ Read out device may be. CRO, X-Y recorder, Tape recorder ...

(b)

A

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| III | 1 |   → When the cell is stimulated by some form of external applied energy, the nature of the Cell membrane wall changes abruptly and it becomes permiable to sodium ions<br>→ The potassium ions which were in higher concentration inside the cell during resting state by leave the cell, but are unable to move as rapidly as sodium ions Because of this the cell has a slightly positive potential inside due to imbalance of potassium ions<br>→ This potential is known as Action Potential and is about +20 mV. During this period the cell is said to be depolarised<br>→ When stimulus is completed, the rush of Sodium ions through the cell membrane is stopped. The membrane reverts back to its orginal condition where in the passage of sodium ions from outside to inside of the cell is again blocked | 8 |

| Question No. | | Scoring Indicator | Marks |
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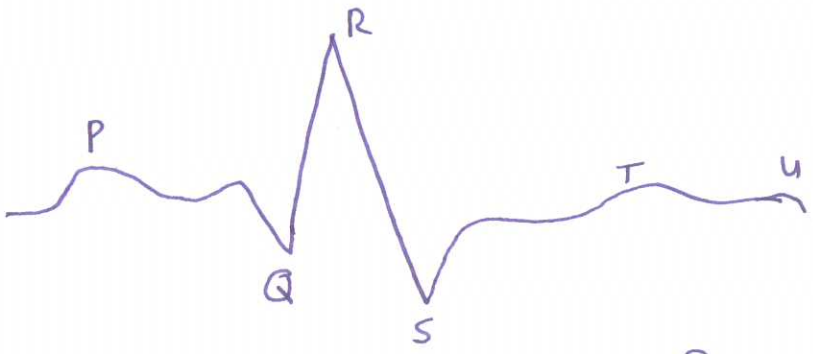
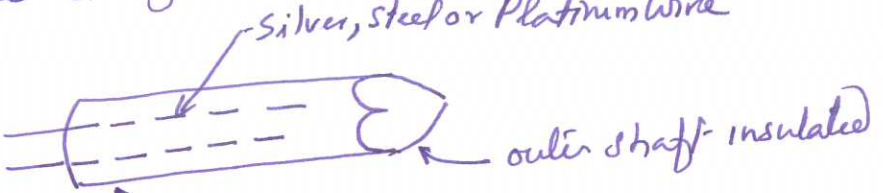
| III | 2 | ECG wave pattern is a display of the potential originated by the myocardium during the cardiac cycle. The amplitude and time details as well as shape of the ECG, used for diagnosis of various diseases and conditions associated with heart. | 7 |




The ECG wave consist of P wave, QRS complex wave, T wave and U wave and duration as follows. The Origin, Amplitude

| Waveform | Origin | Amplitude | Duration in Sec |
|---|---|---|---|
| P wave | — Atrial depolarization or Contraction. | — 0.25 mV. | 0.12 to 0.22 P-R interval |
| QRS Complex. | — Repolarization of the atria and the depolarization of the Ventricles. | — 1.60 mV. | 0.07–0.1 |
| T wave | — Ventricular Repolarization [Relaxation of myocardium] | — 0.1 to 0.5 mV | 0.05–0.15 S-T Interval |
| S-T interval | — Ventricular Contraction. | — | 0.2 |
| U wave | — Slow repolarization of the intraventricular septum (Purkinje Fibres) | .04 | T-U interval. |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| IV | 1. | Electrodes are used to measure bioelectric events. Needle electrodes are used to penetrate the skin to record EEG potentials from a local region of the brain. or EMG potential from a specific group of muscles.<br>→ The needle electrode inserted into or close to, the tissue from which electrical activity is to be recorded, and will record much smaller area than a surface electrode<br>→ They permit the activity of a single motor unit to be studied<br>→ The outer shaft of the needle electrode is usually made of stainless steel. because of its mechanical strength<br>  <br><br>Concentric Needle Electrode<br>→ The recording area of needle electrode is usually less than 1 Sq mm. Figure shows Concentric Needle electrode. It consist of a hollow steel Needle through which runs a Silver, Steel, or Platinum wire too. The P.D. between the outer shaft and the tip of the wire is measured. | 7<br>(Fig-2<br>Eg. 5) |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| IV | 2. | The electrical recordings from the exposed surface of the brain or from the outer surface of the head show continuous electrical activity within the brain and the entire records is called electro encephalogram. EEG. | 8 |


The intensity of the brain waves on the surface of the brain may be as large as 10 μV whereas those recorded from the scalp have a smaller amplitude of 100 μV.

Alpha wave: frequency 8 – 13 Hz

occurance: Found in normal persons when they are awake in a quite resting state. They occur normally in occipital region. During sleep they disappear.

Beta waves: frequency 13 – 30 Hz

occurance:- These are recorded from the parietal and frontal region of the scalp.

Theta wave:- frequency 4 - 8 Hz –

occurance:- These are recorded from the parietal and temporal regions of the scalp of children they particularly occurs during disappointment and frustration in some adults.

| Question No. | | Scoring Indicator | Marks |
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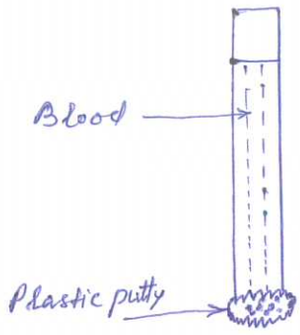
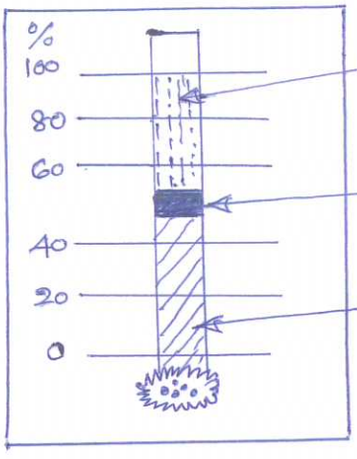
| V | 1. |     → A sample of Blood is taken in a capillary tube of uniform diameter and one end of the tube is sealed with plastic putty as shown in figure<br>→ The capillary tube is rotated 3 to 5 minutes in a special high speed centrifuge so that the blood cells are separated from plasma<br>→ The capillary tube has uniform diameter, thus the red cells and plasma volume can be compared by measuring the lengths of the columns with the help of a simple nomogram.<br>→ The volume of packed red cell at the bottom of the tube gives the 'hematocrit' value which is usually expressed as a percentage of the total blood volume<br>→ If the number of red cell per cubic millimetre of blood is known, we can calculate the mean cell volume.<br>→ The plasma and other cell form a thin buffy layer on the top of the red cells. | (Fig. 3) (Expl. 5) 8 |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| V | 2. | - Optalmology – Photo coagulation of Retinal bleeding<br>– Retinal reattachment<br>– Glaucoma<br>– Lens capsule surgery –<br><br>Gynacology:- – Precancerous lision coagulation<br>– Fallopian tube reconstruction<br>– Fertility microsurgery<br><br>Gastroentrology:- – Gastric bleeding hemostasis.<br>– Hemostatis of colonic bleeding<br>– Hepatectomy<br>– Gall stone removal<br>– Polyp excision<br><br>Dermatology: – Removal of Birth mark<br>– Cutaneous tattoo excision<br>– Varicose vein excision<br><br>Oncology: – Photoradiation of tumors<br><br>Orthopaedics – Joint surgery for removing artifacts<br>– Arthroplastics<br>– Born tumor excision<br>Thoracic Surgery –<br>– Lung cancer diagnosis and treatment<br>– Heart revascularization<br>Neurosurgery :– Spinal and brain tumor excision | 7 |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| | | - Face and Skull deformity reconstruction<br>- Mid line structure of frontal brain<br>Urology - Kidney stone removal<br>- Bladder tumor removal<br>- Penile carcinoma<br>- Bladder bleeding | (any 7) |
| VI | 1. | ND-YAG. Laser -<br>It is a Crystalline solid state Laser. It employs ND-YAG. [Neodimium - Yittrium Aluminium Garnate] crystal as active medium. It is a four level Laser system the $Nd^{+3}$ ions replace Yittrium ions in the Lattice, with a maximum possible doping level of about 1.5%<br>The laser arrangement consist of a Nd-YAG. rod placed whith in an elliptical cavity. The pumping of the laser rod is generally by pulsed or continuous discharge tube<br>In this Laser trasition is more easily Converted with respect to the intermediate transition Level than the three level trasitions of ruby laser. because it has four level transitions It is easy to achieve a populalion inversion in Nd-YAG. because it is measured relative to other excited state instead of the ground state. | (7) |

| Question No. | | Scoring Indicator | Marks |
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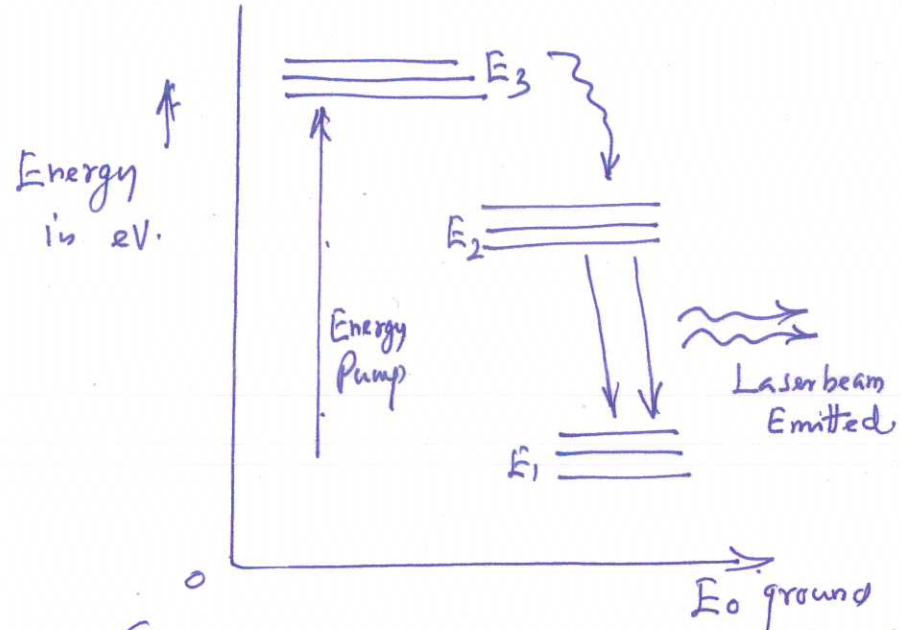


Energy level diagram - Nd YAG Laser

(Fig - 2. Expl. 5)

VI 2.

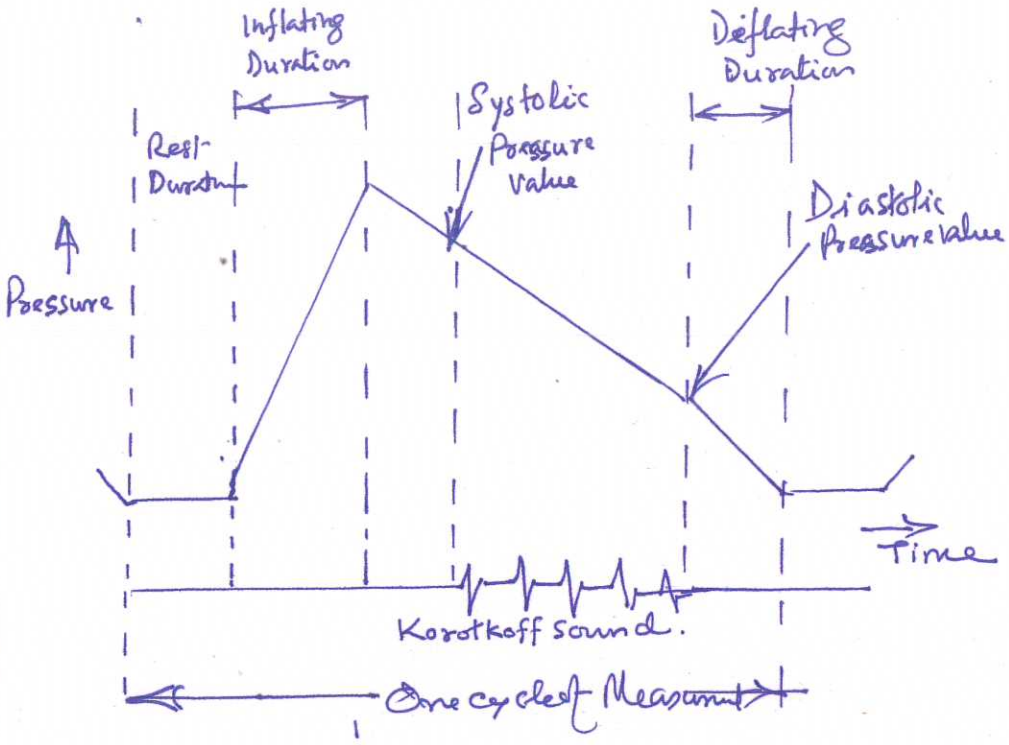


Fig - 2 + Expln - 6

The indirect method of blood pressure measurement will make use of a sphygmomanometer and a stethoscope. The Sphygmomanometer consist of an inflatable pressure cuff and a mercury manometer to measure the pressure in the cuff

| Question No. | Scoring Indicator | Marks |
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| | The cuff constist of a rubber bladder and will have a fabric covering that can be wrapped around the upper arm upper arm. and can be fixed with the help of hook prousded. The cuff is usually inflated manually with the help of a rubber bulb and deflated (pushed out air) slowly through a valve. The stethescope carries the sound energy to the ear of the physician via air column. This sphygmomanometer and stethescope arrangement is used to obtain an average arterial pressure<br>→ The cuff is placed over the upper arm, containing the artery and the pressure is raised to a level well above the systolic pressure so that the blood flow is completely terminated.<br>— Now the preassure in the cuff released slowly and the pressure in the cuff reaches a level below the systolic pressure, blood flow for a brief period.<br>— If the cuff pressure is made to fall just below the diastolic pressure value the blood flows normally without interruption and the Korotkoff sound appear first, when the cuff pressure fall just below the Systolic pressure and the sound can be heard thrgh the Stethoscope<br>— The korotkoff sound disappear when the cuff pressure falls just below the distolic pressure<br>→ The pressure of the Cuff can be read on the manometer. When the first korotkoff sound is heard is considered as the systolic pressure<br>- The figure shows : One cycle of measurement of Blood pressure based on the principle of indirect method | |

| Question No. | | Scoring Indicator | Marks |
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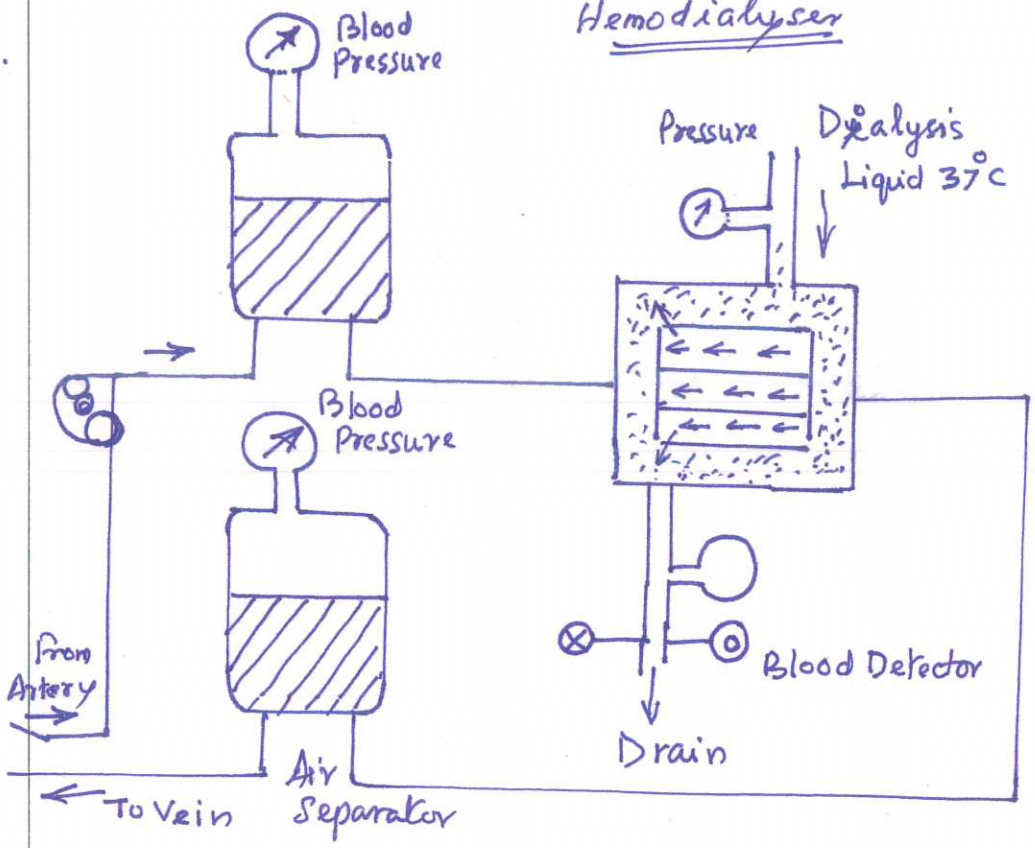
| VII | 1. | | (fig-4 Expl. 5) 9 |




Hemodialysis is a process that involves the removal of chemical substances from blood by passing it through tubes sorrounded by Semipermiable membranes. It is accomplished by puncturing two needles through an artery and Vein and circulating the patients blood through a plastic tube. This coiled plastic tube is kept in a dialysate solution of dextrose and salt of Ca, Mg, K and Na. Osmotic pressure balanced in such a way that toxins such as urea, creatinine and uricacid gradually pass through plastic tube and cellophane membrane in to the dialysate solution. The semepermiable membrane passes salt and small molecules. but not blood cells and large protein molecules

| Question No. | Scoring Indicator | Marks |
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→ In hemodialyser The arterio-venous shunt is opened and connected to the dialyser. Using a blood pump the blood is pumped in to the number of planar sheets of cellophane which are pressed together in a frame Blood flows in alternate spaces and the dialysate flows in the others. as shown.

→ The dialysate is an electrolyte, through the cellophane sheets, Urea, creatinine, uric acid and phosphates are diffused from blood to dialysate

→ There is a Blood leak detector to detect rupture of a membrane and pressure monitoring meters are at the input and out put.

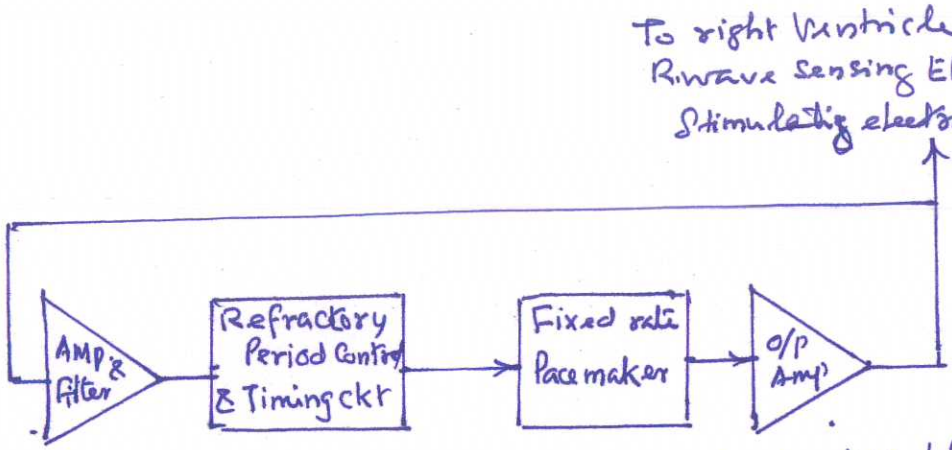
→ A thermostatic control is provided to maintain temperature of the blood at 37°C

The blood is circulated continuously 3 to 6 hrs in the hemodialysis machine and hence get purified.

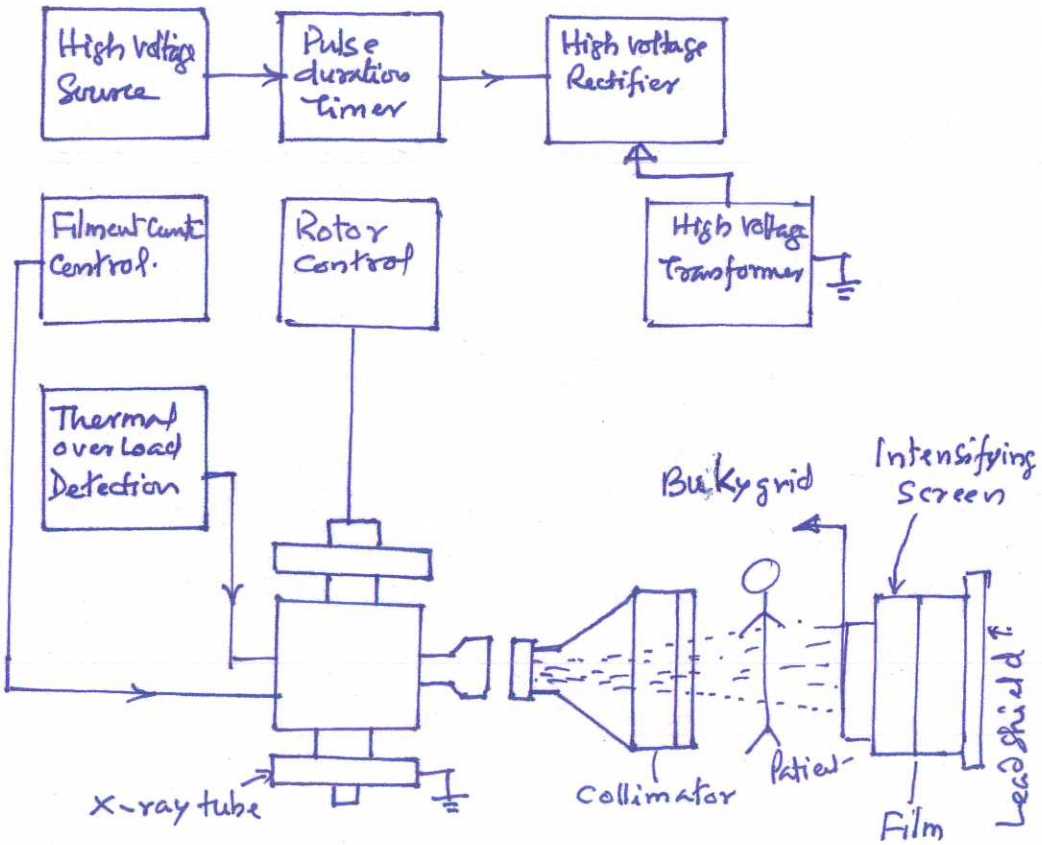
VII 2.

| AC Defibrilators | DC defibrilators. |
|---|---|
| - Simple and easy to operate | → Simple and Safe |
| → Large Currents are required for external defibrillators | → High Energy shock is given by discharging a Capacitor $E = \frac{1}{2}CV^2$ |
| → This current Causes violent | → No desirable side effects |
| → Produces normal heart beat slowly | → Produces normal heart beat effectively |
| - occational burning of skin Under the electrode | → No skin burns. |

6 M.

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| | | → Only an alternating wave is used to deliver shock<br>→ Shock can not be Sync with ECG to correct fibrillation at the right time<br>→ not very effective<br>→ It produces atrial fibrillation while arresting Ventricular fibrillation<br>→ The technician administrating the shock is unsafe<br>→ Different waveforms can be selected to deliver shock<br>→ can be synchronized with ECG to correct fibrillation at right time<br>→ Very effective<br>→ No such effects are observed<br>→ The technician administrating shock is safe. | |
| VIII | 1. |  <br>Patients with only short period of AV block or bundle block can be supplied with a Ventricular synchronized pace maker.<br>→ By using the sensing electrode, the heart rate is detected and is given to the timing ckt in the pacemaker. If detected heart rate is below a certain minimum level, the fixed rate pace maker turned to on and pace the heart | 8<br>(Fig. 3 Expln. 5) |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| | | → The lead used to detect the R wave is now used to stimulate the heart.<br>→ If a natural contraction occurs, the asynchronous pacer's timing is reset so that it will time its next pulse to detect heart beat. Otherwise the asynchronous pacemaker produces pulses at its preset rate<br>→ If the pacemaker may detect noise and interpret as its ventricular excitations, this is eleminated by the incorporation of refractory period circuit or gate circuit after either a paced or natural Contraction.<br>→ A high pass filter with a lower cut off frequency at 20Hz the P wave can be eleminated. which can occcur at random time with respect to Ventricular excitations.<br>→ The R wave is differentiated by such a filter and its peak to peak amplitude is increased using an input filter. | |
| VIII | 2. | Ventelators can functions cyclically. During inspiration, air or other gaseous mixture is pumped into the Lungs. During expiration, the pressure is made to cease. this cycle is controlled by different ways<br>1. Pressure cycled Ventilator<br>2. Volume Cycled Ventilator<br>3. Servo Controlled Ventilator | 7 |

| Question No. | | Scoring Indicator | Marks |
|---|---|---|---|
| | | → Pressure cycled Ventilators, the aspiration is terminated when the gaseous mixture or air pumped in to the lungs reaches a predetermined pressure. These are simple in construction and reliable in operation<br>→ Volume Cycled Ventilators, A predetermined Volume of gas is given to the patient for each breath. During inspiration the constant volume of air is sent to the lungs by applying a pressure to a chamber containing known volume<br>→ Servo Controlled Ventilator, modern electronic circuit are used to regulate inspiration and expiration process. The feed back and control techniques are used to achieve this. | |
| IX | 1. |  | Fig 4 } 9.<br>Expln 5 } |

| Question No. | Scoring Indicator | Marks |
|---|---|---|
| | The basic components of X ray machine are X-ray tube, Power supply arrangement, Aluminium filters, Collimators, Bucky grid and lead shield. The high voltage source is an auto transformer which is used to get high voltages from 20 to 200kV in the machine<br>→ There is a timer which controls the exposure time so that the patient does not receive an excessive dose<br>→ Another high voltage transformer used to step up the voltage further and a high voltage rectifier, for a high dc voltage without any ac ripples is generated.<br>→ The filament current control provides the necessary current (mA) for the filament of the cathode in the X ray tube.<br>→ The X-ray tube, emitted rays contains a broad range of frequencies. With the help of Aluminium filters lower X ray frequencies are absorbed<br>→ A bucky grid is provided between the patient and the film cassette to provide to reduce scattered radiation and improve the sharpness of image and the density of the image in the film can be reduced by using image intensifier<br>→ The cassette loaded in the with X ray film is processed in the dark room and the photographed image can be seen after developing the X-ray film. | |

| Question No. | | Scoring Indicator | Marks |
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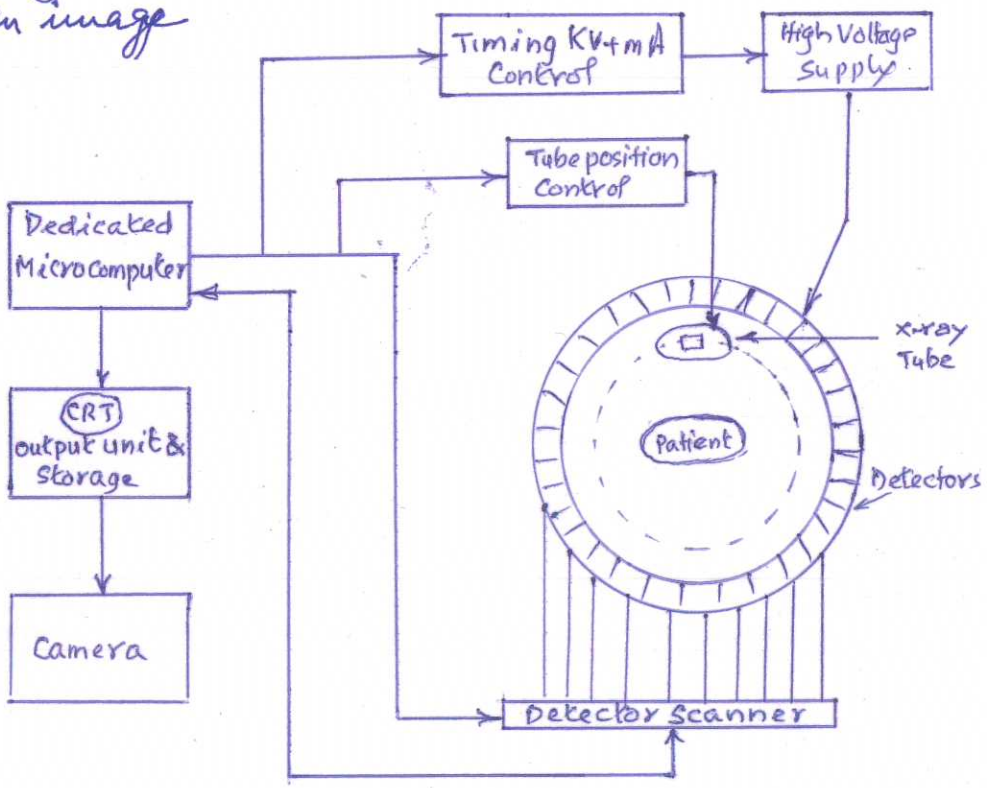
| IX | 2. | Basic principle of Magnetic Resonance Imaging. technique make the use of the RF region of the electromagnetic spectra to provide an image. Here, first a patient is placed in an external magnetic field which causes the magnetisation of protons of hydrogen atoms in his body (80% of human body contains hydrogen atoms) Due to magnetization, these protons align and proced about the external magnetic field. Now a radio frequency pulse at resonence frequency is transmitted in to the patient under controlled and prescribed condition, At resonance conditions the individual protons responds by emitting a radio frequency signal. This is called nuclear magnetic resonance signal. These emitted signals by the protons, during their Return from higher energy state to ground state are picked up by the RF Coils and processed by computers using fourier transforming technique to produce an image | 6. |
| X | 1. |  | 9<br>(Fig 4 Expl -5) |

| Question No. | Scoring Indicator | Marks |
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In this Arrangement the X-ray tube and photographic film are moved in synchronism So that one plane of the patient under examination remains in focus, while all other planes are blurred In computed tomography, The picture is made by viewing the patient via X ray imaging from numerous angles, mathematically reconstructing the detailed structures and displaying the reconstruction on a video monitor

The timing, anode voltage(KV) and beam current(mA) are controlled by a computer thrgh a control bus.

The high voltage dc Power supply drives an X-ray tube that can be mechanically rotated along the circumference of the gantry.

The patient is lying in a tube through the centre of the gantry

The x-ray pass through the patient and are partially absorbed and the remaining x ray photons impinge up on several of as many as 1000 radiations detectors fixed around the circumference of gantry. When they strike the detector the x ray photons are converted to scintillations. The computer senses the position of x ray tube and samples of the out put of the detector along a diameter line opposite to the x ray tube.

The out put unit then produce a visual image of a transverse plane cross section of the patient on the cathode ray tube

It can also be photographed by the camera to produce a hard copy of record. The CT machine can obtain slices in 1-2 Seconds in high resolution.

| Question No. | | Scoring Indicator | Marks |
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| | | In CT Scanning System, four major Subsystems are provided That is Scanning System, Processing Unit, Viewing part and Storage Unit.<br><br>Scanning System take Suitable readings for a picture to be reconstructed<br>Processing Unit:- Converts these readings into intelligible picture informations by using different reconstructions methods like Back projection method Interaction method and analytical method.<br>Viewing part:- Presents the information in visual form.<br>Storage Unit:- enables the information to be stored for Subsequent analysis. | |
| X | 2. | → The safety codes for the Bio-medical equipment to be followed<br>→ Electrical safety analysers that generate hard copies of test result have to be used<br>→ The power outlets should have three-prong wall receptacles that meet the ground retestion force requirement as per the relevent standards<br>→ Electrical testing of a wall receptacle should be made to determine whether power is available at the receptacle and if its polarity is correct<br>→ Measurement of leakage current and ground resistance test must carried out periodically on instruments normally applied to the patients | (6) |

| Question No. | Scoring Indicator | Marks |
|---|---|---|
| | → Leakage current test involves<br>a) Chasis leakage current measurements<br>b) Leakage current in patient leads<br>c) Ground-continuity tests<br><br>→ As medical equipment are sensitive to picking up Electromagnetic radiations, proper care must be taken to minimize them | |