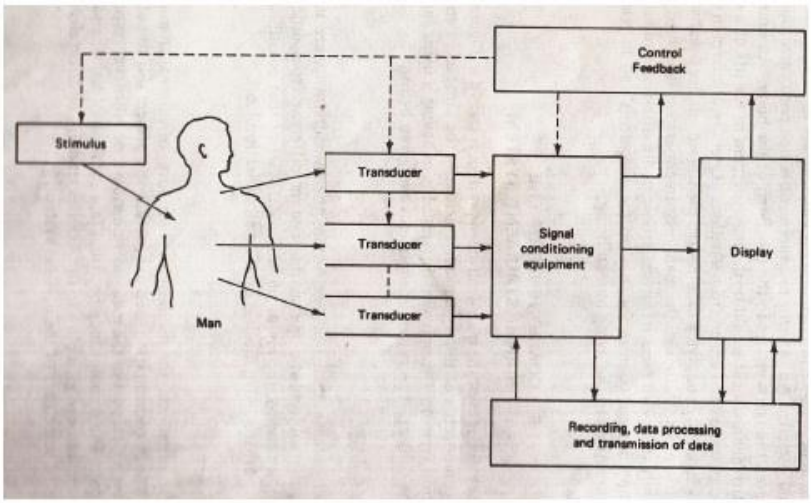
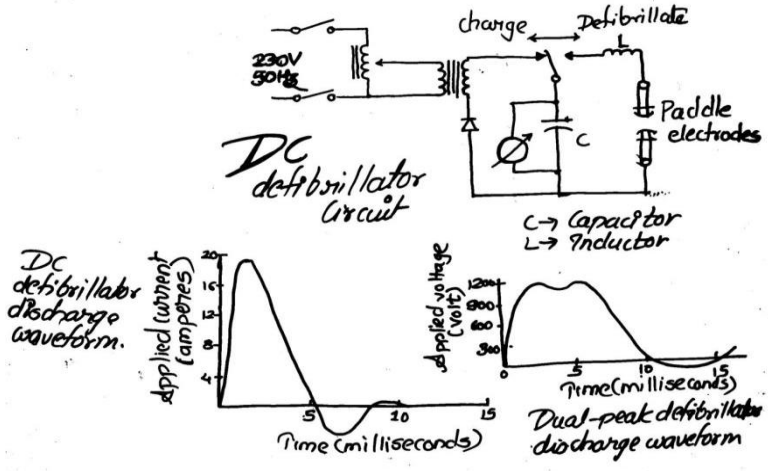
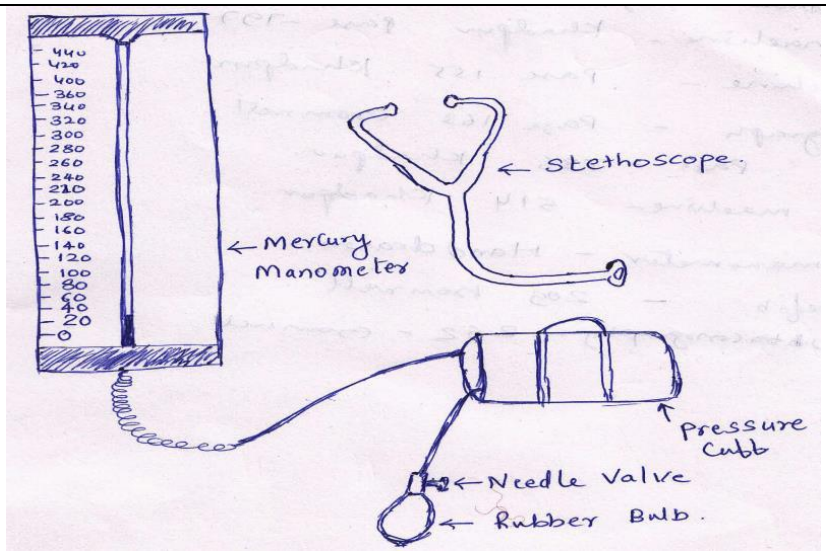
Important Instructions to examiners:

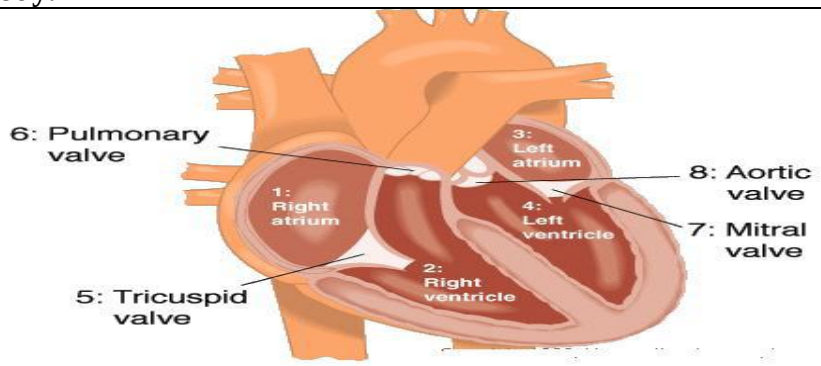
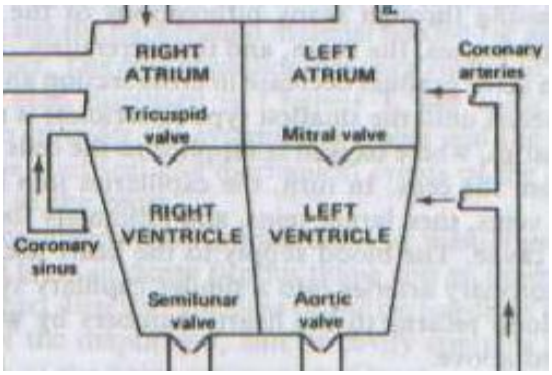
1) The answers should be examined by keywords and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

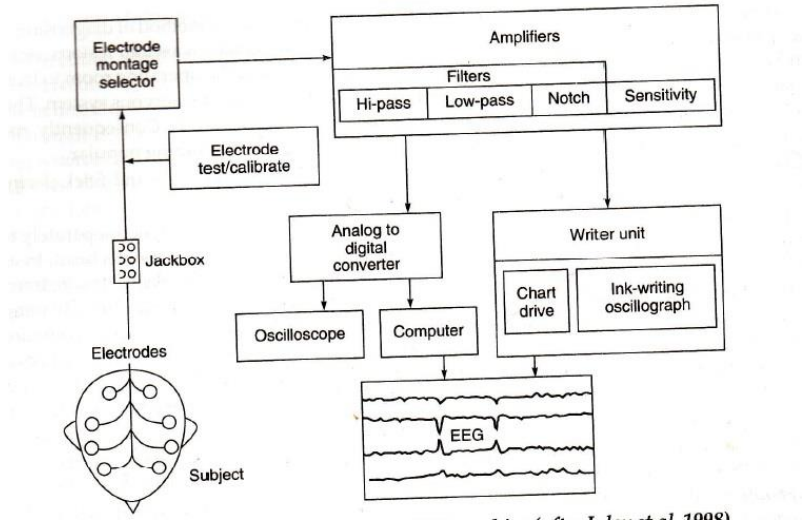
Q. No.	Question & its Answer	Remark	Total Marks
01 a)	**Attempt any THREE of the following**		12
(i)	**Draw the block diagram of Man-Instrument system. State functions of its component.**		04
Ans.	**Diagram:**  **Fig: Block diagram of Man – Instrument system** **Function of Man – Instrument system :** The basic components of the man instrument system are: **Subject**: The subject is the human being on whom the measurements	**Diagram 02 marks**	

	are made. **Stimulus**: Stimulus generates response. The instrumentation used to generate and present this stimulus to the subject is the vital part of man-instrument system whenever responses are measure. E.g. visual (flash of light), auditory (a tone), etc. **Transducer**: A transducer is device used to produce an electrical signal that is an analog of the phenomenon being measured. **Signal conditioning equipment**: This part of the system amplifies, modifies, or in any other ways changes the electric output of the transducer to satisfy the functions of the system and to prepare signals suitable for operating the display or recording equipment that follows. **Display equipment**: The input to the display device is the modified electric signal from the signal conditioning equipment which is converted into a form that can be perceived by one o the human's senses in a meaningful way. E.g. graphic pen recorder for recoding ECG signal. **Recording, Data processing, and Transmission**: Recording instruments are required to record the desirable information that can be used to transmit or for possible later use. E.g. on line digital computer, recording equipment etc. **Control devices**: Where it is necessary or desirable to have automatic control of the stimulus, transducers, or any other part of the man instrument system, a control system is incorporated which uses control devices.	**Description 02 marks**	
(ii)	**Describe D.C. deffibrillator working with neat diagram.**		**04**
Ans.	 **Fig: DC defibrillator circuit and discharge waveform**	**Diagram 02 marks**	

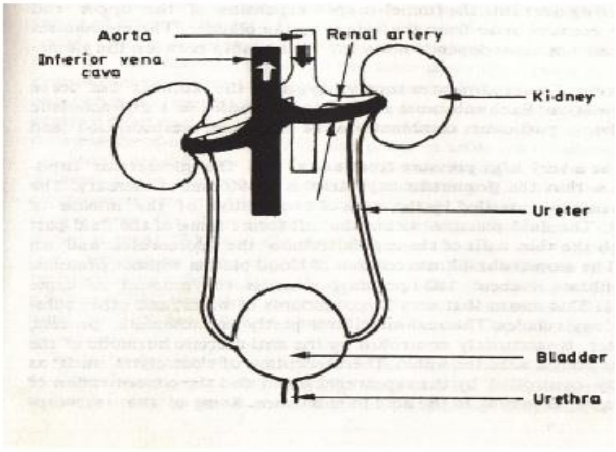
	In defibrillator a capacitor is charged to a high DC voltage and then rapidly discharged through the paddle electrodes across the chest of the patient. An inductor in the defibrillator is used to shape the wave in order to avoid sharp current spike. Depending on the energy setting the amount of electrical energy discharged by the capacitor may of the range 100W and 400 W per second.	**Description 02 marks**	
(iii)	**What is 'Demand Pacemaker'? When it is used?**		**04**
Ans.	• **Demand pacemaker:-** The pacemaker which detect spontaneous ventricular activity and the output of which is either suppressed or discharged in order to make the impulse fall within the safe period of the QRS complex is known as Demand Pacemaker. Demand pacemakers can discharge electrical impulses when the heart rate falls outside of a predetermined zone or skips a beat. • **Uses:** 1. Demand pacemakers are thus used to regulate arrhythmias, which are heart rhythms that are irregular, where the heart beats either too rapidly or too slowly. 2. They are implanted to regulate heart-rate problems that occur over extended periods of time. 3. Used to prevent occurrence of competitive beats: They occur when the heart's intrinsic pace-making mechanism and an fixed-rate pacemaker stimulate a heartbeat at the same time. The demand pacemaker senses the activity of the heart, which allows it to refrain from emitting electrical impulses while the heart is intrinsically firing. This eliminates the possibility for competitive beats to occur. Doing so has increased the clinical applicability of pacemaker treatment for conditions that would elicit a competitive beat from a fixed-rate pacemaker.	**Defination 02 marks** **01 mark for each use(any two)**	
(iv)	**Describe working of blood pressure measuring instrument 'Sphygmomanometer' with neat diagram.**		**04**

Ans.	 **(Note: any other relevant diagram may considered)** **Description :** • The familiar indirect method of measuring blood pressure involves use of Sphygmomanometer and a stethoscope. Sphygmomanometer consists of an inflatable pressure cuff and mercury manometer to measure the pressure in the cuff. • The cuff consists of a rubber bladder inside an inelastic fabric covering that can be wrapped around the upper arm and fastened with either hook or a Velcro fastener. The cuff is normally inflated manually with rubber bladder and deflated slowly through a needle valve. • The Sphygmomanometer works on the principle of that when the cuff is placed on the upper arm and inflated (filled with air pressure), arterial blood can flow past the cuff only when the arterial pressure exceeds the pressure in the cuff. • So first pressure in cuff is increased by inflating cuff with the help of rubber bladder pumping manually above systolic pressure at this point no sound is heard through the stethoscope which is placed over the brachial artery. For that artery has been collapse by the pressure of the cuff. • The pressure in the artery gradually reduced by opening needle vale slowly. • As soon as cuff pressure falls below systolic pressure, small amount of blood Spurt past the cuff and KOROTKOFF sounds begin to be heard through stethoscope. • The pressure of the cuff that is indicated on MANOMETER when	**01 mark for diagram** **03 marks for brief explanation**	

	the first Korotkoff sound is heard is recorded as the systolic blood pressure. Standard range of systolic blood pressure in normal adult is in the range of 95-140 mm of Hg with 120 mm of Hg being average. • As the pressure in the cuff continues to drop the Korotkoff sound continue until cuff pressure is no longer sufficient to occlude the vessel. Below this pressure Korotkoff sound disappears marking the value of Diastolic Pressure. Standard range of diastolic blood pressure in normal adult is in the range of 60-90 mm of Hg with 80 mm of Hg being average.		
(b)	**Attempt any ONE of the following**		**06**
(i)	**Draw neat labelled diagram of human heart structure. Describe its working with blood circulation in different parts of human body.**		**06**
Ans.	 **OR**  **Fig: Human heart structure** The heart is divided into four chambers: right atrium (RA) ,right ventricle (RV) ,left atrium (LA),left ventricle (LV) . • All blood enters the right side of the heart through two veins: The **superior vena cava** (SVC) and the **inferior vena cava** (IVC). • The SVC collects blood from the upper half of the body. The	**03 marks for neat labeled diagram** **03 marks for brief explanation**	

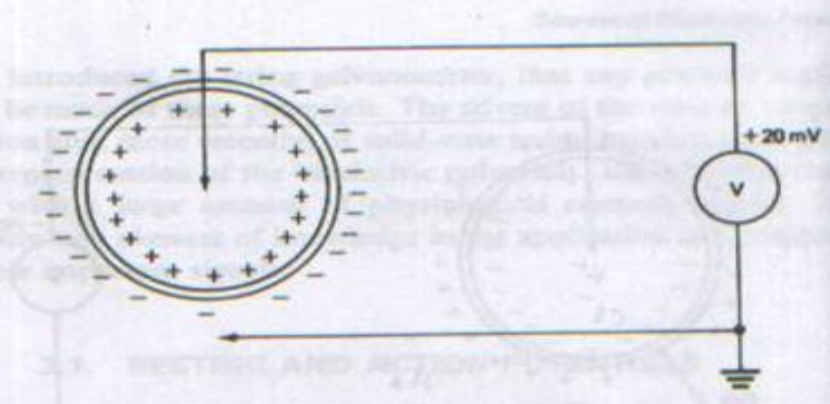
	IVC collects blood from the lower half of the body. Blood leaves the SVC and the IVC and enters the **right atrium** (RA). • When the RA contracts, the blood goes through the **tricuspid valve** and into the **right ventricle** (RV). When the RV contracts, blood is pumped through the **pulmonary valve**, into the **pulmonary artery** (PA) and into the lungs where it picks up oxygen. • Blood returning from the body is relatively poor in oxygen. It needs to be full of oxygen before being returned to the body. So the right side of the heart pumps blood to the lungs first to pick up oxygen before going to the left side of the heart where it is returned to the body full of oxygen. • Blood now returns to the heart from the lungs by way of the **pulmonary veins** and goes into the **left atrium**. When the LA contracts, blood travels through the **mitral valve** and into the **left ventricle** . • The LV is a very important chamber that pumps blood through the **aortic valve** and into the **aorta**. The aorta is the main artery of the body. It receives all the blood that the heart has pumped out and distributes it to the rest of the body. • The LV has a thicker muscle than any other heart chamber because it must pump blood to the rest of the body against much higher pressure in the general circulation (blood pressure).		
(ii)	**Draw the neat block diagram of Electroencephalogram. Explain its working. Enlist any two specifications of it.**		**06**
Ans.	**Diagram-**  **Fig: Block diagram of EEG**	**02 marks for diagram**	

	The basic block diagram of an EEG machine with both analog and digital components is shown in fig. 1) Montages: A pattern electrodes on the head and channels they are connected to is called a montage. Montages are always symmetrical. 2) Electrode Montage selector: EEG signals are transmitted from the electrodes to the head box, which is labeled according to the 10-20 system, and then to the montage selector. The montage selector on EEG machine is a large panel containing switches that allow the user to select which electrode pair will have signals subtracted from each other to create an array of channel of output called montage. 3) Preamplifier: Every channel has an individual multistage, ac coupled, very sensitive amplifier with differential input and adjustable gain in wide range. Its frequency response can be selected by a single stage passive filters. 4) Sensitivity control: The overall sensitivity of an EEG machine is the gain of the amplifier multiplied by the sensitivity of the writer. An EEG machine has two types of gain controls. One is variable and it is used to equalize the sensitivities of all channels. The other control operates in steps and is meant to increase or reduce the sensitivity of channel by known amount. 5) Filters: An EEG contains muscle artefacts due to the contraction of the scalp and neck muscle, the artefacts are large and sharp causes great difficulty in both clinical and automated EEG interpretation. These artefacts are generally removed using low pass filters. The filters on an EEG machine has several selectable position. 6) Noise: EEG amplifiers are selected for minimum noise level, which is expressed in terms of an equivalent input voltage. 7) Writing part: The writing part of an EEG machine is usually of the ink type direct writing recorder. 8) Paper Drive: This is provided by a synchronous motor. An accurate and stable paper drive mechanism is necessary. There are several papers speeds available for selection. 9) Channels: Commercial EEG machine have up to 32 channels, although 8 or 16 channels are more common.	**03 marks for brief explanation**	
	• **Specification:** 1) Channels: Commercial EEG machine have up to 32 channels 2) The ink jet recording system is used which gives response up to 1000 hz. 3) The motor used for paper drive has speed of 15, 30 or	**01 mark for any two specificati**	

	60mm/s. 4) Noise: EEG amplifiers selected for minimum noise level, 2mv is acceptable fig. for EEG recording. 5) Frequency range: For standard EEG machine frequency range is from 0.1hz to 70hz.	**on**	
2	**Attempt any FOUR of the following**		**16**
a)	**Describe function of Kidney in human body with neat diagram.**		**04**
Ans.	**Diagram:**  **Fig: Human kidney** Main function of kidney is to form urine out of blood plasma. It consists of two processes i) To form urine out of blood plasma. ii) removal of waste product and iii) Regulation of composition of blood plasma. iv) To maintain osmotic pressure v)PH & electrolyte composition of extra cellular body fluids	**02 marks for diagram** **01 mark for each function(any two)**	
b)	**Define the term :** **i) Action Potential** **ii) Resting Potential**		**04**
Ans.	**i) Action Potential:** When cell is excited by any external excitation or stimulus then	**02 marks for definition**	

property of cell membrane changes, which allows entry of Na^+ ions. The large number of Na^+ ions tries to enter inside the cell than the number of Cl^- ions leaving the cell body. So after some time inside the cell body potential is more +ve than outside. This developed potential in the cell is called as "action potential". A decrease in resting membrane potential difference is called Depolarization.

Diagram of action potential :

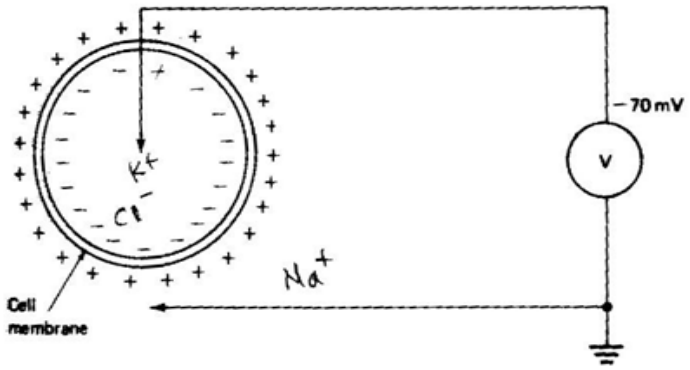
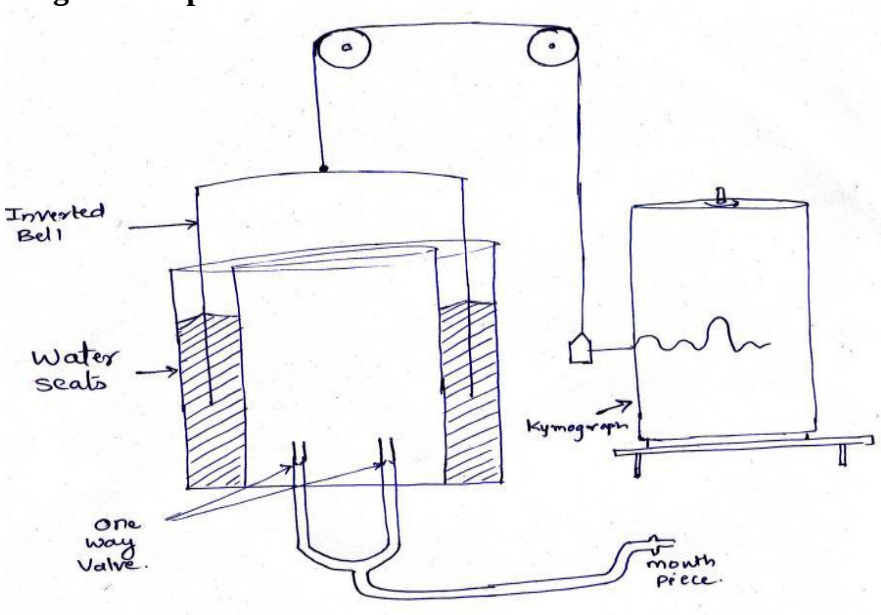


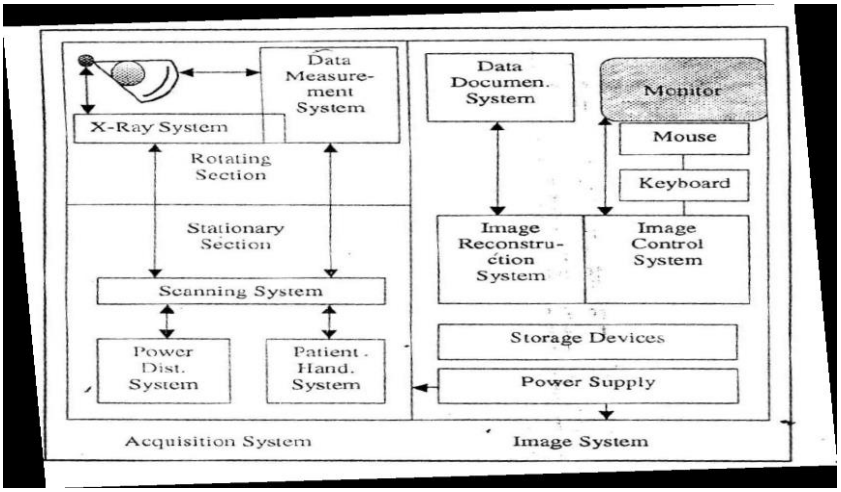
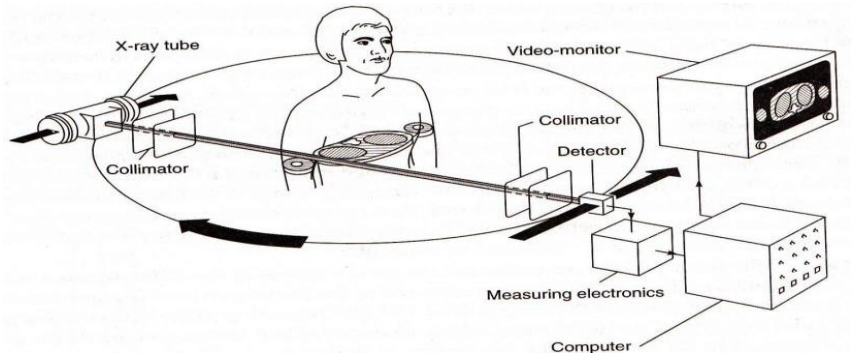
of action potential with diagram

ii) Resting Potential:

Surrounding the cell of the body or body fluids. These fluids of conductive solutions containing charged atoms known as ions. The principle ions are sodium (Na^+), potassium (K^+) and chloride(Cl^-). The membrane of excitable cell readily permit entry of K^+ and Cl^- restricts flow of NaCl. The inability of sodium to penetrate the membrane results in two conditions. First, the concentration of sodium ion inside the cell much lower than in the intercellular fluid outside. Since the sodium ions are positive, these would tend to make the outside of the cell more positive than the inside. Second, in an attempt to balance the electric charge, additional potassium ions, which are also positive, enters the cell, causing a higher concentration of K^+ ions on the inside than on the outside. These charge balance can not be achieved, however because of the concentration imbalance of K^+ ions. Equilibrium is reached with the potential difference across the membrane, negative on the inside and positive on the outside.
This membrane potential is called the resting potential of the cell and is maintained until some kind of disturbance upset the equilibrium

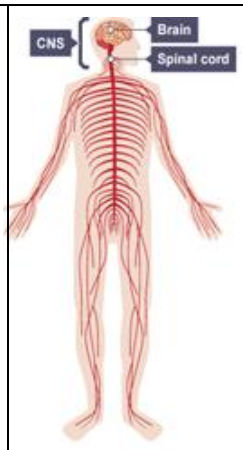
02 marks for definition of resting potential with diagram

	Diagram of resting potential: 		
c)	**Describe the working of respiration rate measuring instrument Spirometer with neat diagram.**		**04**
Ans.	**Diagram of Spirometer :**  **OR any other relevant diagram** **Working of Spirometer :** Above figure shows the diagram for Spirometer. Spirometer is a device which is used to determine all lung volumes and capacities. The standard Spirometer consists of a movable bell inverted over a chamber of water. Inside the bell is the gas that is to be breathed. The bell is counterbalanced by a weight to maintain the gas inside the atmospheric pressure so that its height above the water is proportional to the amount of gas in the bell.	**02 marks for diagram** **02 marks for brief explanation**	

	A breathing tube connects the mouth of the patient to the Spirometer. Thus as the patient breathe gas from the tube there are changes in internal volume of Spirometer which causes proportional displacement of bell downwards. Similarly, as the patient breaths back into the tube, the bell moves up proportional to the change in internal volume. The motion is recorded on a rotating drum i.e. kymogram through a pen that is attached to a counter balancing mechanism		
d)	**Draw the neat diagram of CAT machine. State functions of its component.**		**04**
Ans.	**Diagram of CT Scan:**  **OR**  **Functions of its component:** The CT scanner consists of gantry, patient table, X-ray tube, detector assembly, computer and monitor. X ray tube and detector	**02 marks for diagram**	

	assembly mounted opposite each other in a rigid gantry rotates once around the patient. **The x ray tube** emits the x rays at short intervals so that during a full rotation a number of sets of absorption values are collected by detectors. Computer process this data and produces images of the measured values. **The image system** controls the function of CT scan such as reconstruction, display and evaluation of the CT image. The image control system is connected to monitor, keyboard, mouse and various storage devices such as disks, tape etc. **The image reconstruction system** receives measure data and performs the image reconstruction on it. These images are processed and displayed. The data documentation system is connected to the image reconstruction system and is used to photograph the reconstructed CT image. **Acquisition system** acquires the data. The data measurement system belongs to the rotating part of the gantry and contains all the elements to measure the attenuated radiation and to transfer this to image system for reconstruction and display of CT image. X ray system also belongs to the rotating part of gantry. **The scanning system** contains the function of gantry rotation, gantry tilt, to exchange data with X ray system and data measurement. **The patient handling system** consists of patient table, motor for vertical and horizontal drive and system controller. **The power distribution system** provides power supply to all the various systems shown in figure.	**02 marks for brief explanation**	
e)	**State function of following laboratory equipments(any two of each)** **i) Incubator ii) Autoclave**		**04**
Ans.	**i) Incubator:** 1) To provide a controlled, contaminant-free environment for safe, reliable work with cell and tissue cultures also used to maintain an	**02 marks for two function each**	

	infant. 2) Incubators are essential for a lot of experimental work in cell biology, microbiology and molecular biology and are used to culture both bacterial as well as eukaryotic cells. 3) Microbiological incubators are used for the growth and storage of bacterial cultures. 4) To provide suitable conditions for a chemical or biological reactions. **ii) Autoclave:** 1) Autoclaves prevent the transfer of germs and viruses from devices used by professional service providers such as medical professionals, tattoo artists, professional nail salons, veterinarians and dentists. **2)** The **autoclave** carries out exact function of sterilizing materials. It is a machine that uses pressure and steam to reach and maintain a temperature that is too high for any microorganisms or their spores to live.		
3	**Attempt any FOUR of the following**		**16**
a)	**Describe the working of nervous system in human body with neat diagram**		**04**
Ans.	The human nervous system consists of: 1) the **central nervous system** (CNS) – the brain and spinal cord 2) the **peripheral nervous system** – nerve cells that carry information to or from the CNS		



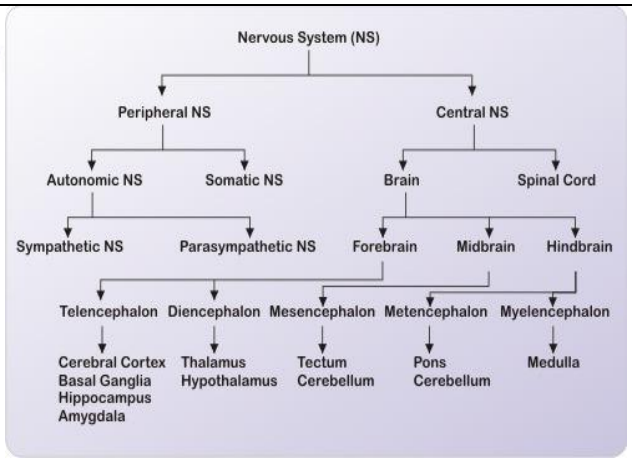


Diagram-02 marks

1) The brain

The brain lies within the skull. The brain consists of three principal parts:

- the brain stem
- the cerebrum
- the cerebellum

Description-02 marks

➢ **The brain stem**

The brain stem connects the spinal cord to the centre of the brain just below the cerebral cortex.

It has centres for regulating work performed by the heart and blood circulation and respiratory centres

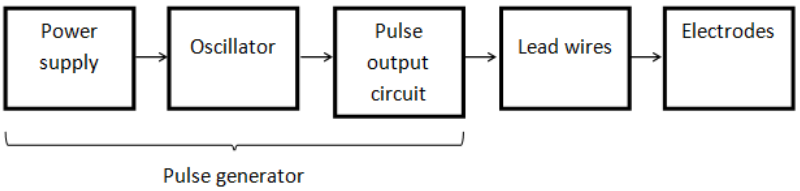
➢ **The cerebrum**

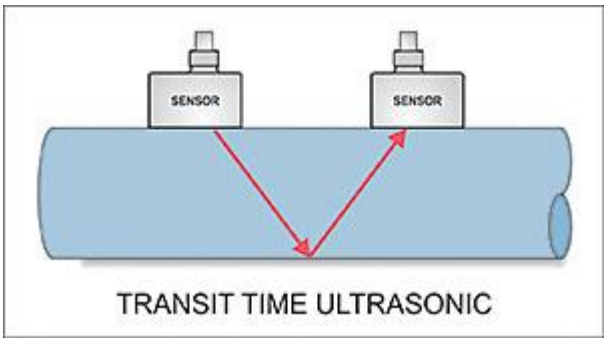
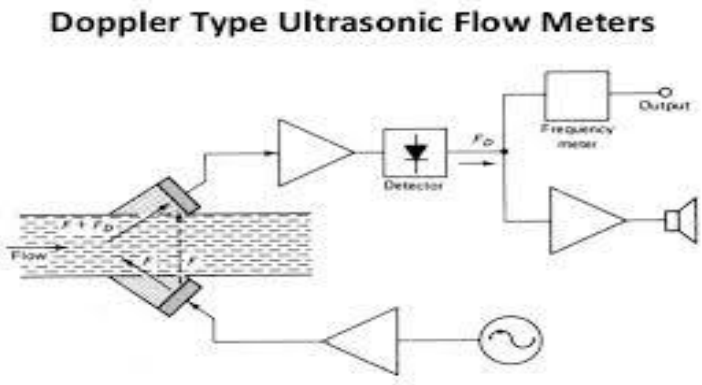
The cerebrum is divided into two hemispheres. Each hemisphere controls the activities of the side of the body opposite that hemisphere.

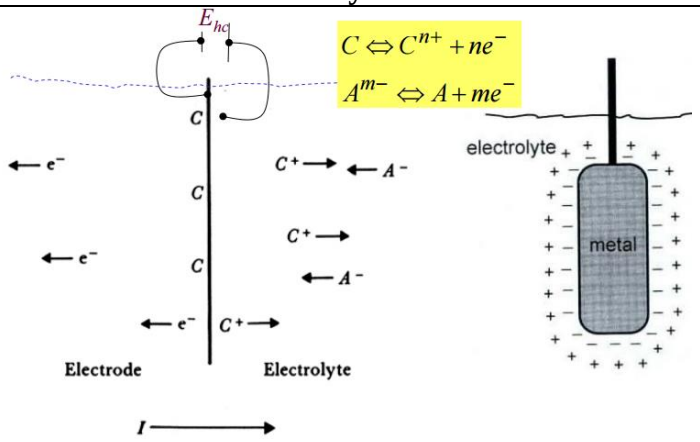
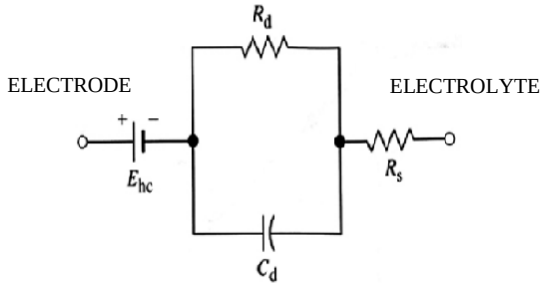
- The hemispheres are further divided into four lobes:Frontal lobe- intelligence, constructive imagination & thought. Basis of higher mental functions
- Temporal lobes – storage in the long term memory
- Parietal lobe – sensation from the opposite half of the body.
- Occipital lobe – stores visual memories.

➢ **The cerebellum**

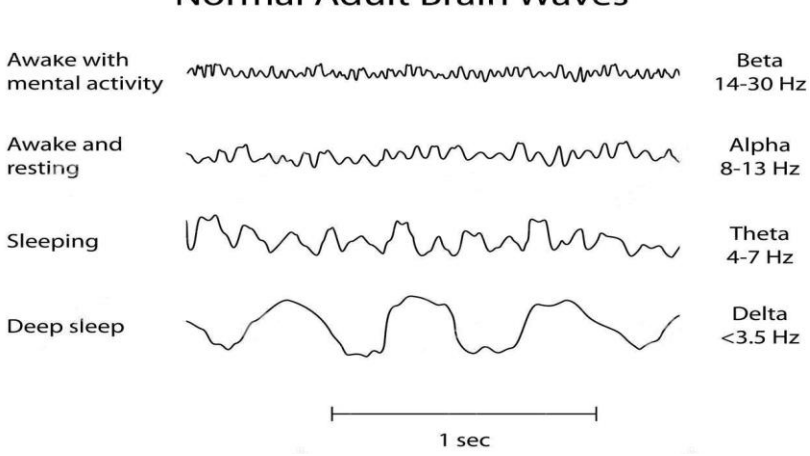
This is located behind and below the cerebrum. T acts as a

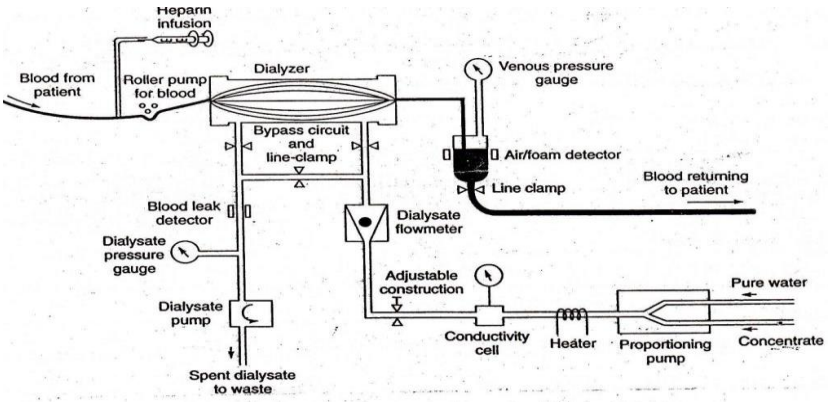
	physiological microcomputer. ➢ **The spinal cord** The spinal cord is along tube like structure which extends from the brain. The spinal cord is composed of a series of 31 segments. A pair of spinal nerves comes out of each segment. The region of the spinal cord from which a pair of spinal nerves originates is called the spinal segment. Both motor and sensory nerves are located in the spinal cord. ➢ **Peripheral nervous system-** Peripheral nervous system is made up of the Somatic and the Autonomic nervous systemsNerves go from spinal cord to arms , hands , legs & feet. Nerve cells are also called neurones. They are adapted to carry electrical impulses from one place to another.		
b)	**Draw the neat diagram of external pacemaker. Explain in working.**		**04**
Ans.	 External pacemaker is used to start the normal rhythm of the heart in case of cardiac failure. Metal electrodes are placed on the surface of the body after applying jelly for proper contact and for preventing burning of the skin. Pulses are then applied .they can be delivered continuously if the heart rate is below a preset value , irrespective of the electrical activity of the heart. On demand R- wave synchronizing pacing – the time interval between two R-R waves is measured and if this time interval is large, then pulses are given. On demand hysteresis pacing – this pacemaker starts pacing at 7 ppm automatically whenever the heart rate goes below 60. All external pacemaker require 150 V (max.) amplitude across an impedance of 1 KΩ. Each pulse applied by the external pacemaker	**Diagram-02 marks** **Description-02 marks**	

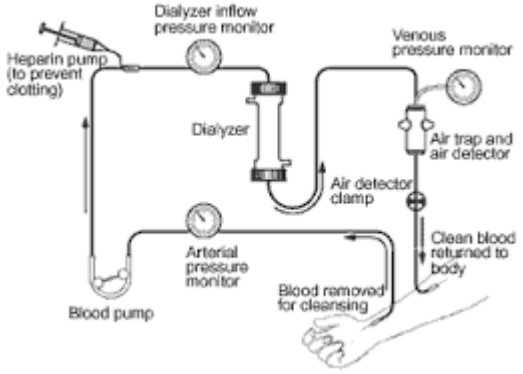
	causes an uncomfortable contraction of thoracic muscle around the area of the electrode as well as burning of the skin. Hence external pacemakers are used only temporary heart blocks either during or after surgery, or for short term treatment of arrhythmia.		
c)	**Describe the working of ultrasonic method of blood flow measurement with neat diagram.**		**04**
Ans.	**1) Transit time blood flow meter**  Transit Time flowmeters measure the time it takes for an ultrasonic signal transmitted from one sensor, to cross a blood vessel and be received by a second sensor. Upstream and downstream time measurements are compared. With no flow, the transit time would be equal in both directions. With flow, sound will travel faster in the direction of flow and slower against the flow. **2) Doppler type blood flow meter**  An oscillator, operating at a frequency of several megahertz, excites a piezoelectric transducer. This transducer is coupled to the wall of an exposed blood vessel and sends an ultrasonic beam with a frequency F into the flowing blood. A small part of the transmitted energy is scattered back and is received by a second transducer arranged opposite the first one. Because the scattering occurs mainly	**(Any one Type)** **Diagram-02 marks** **Description-02 marks**	

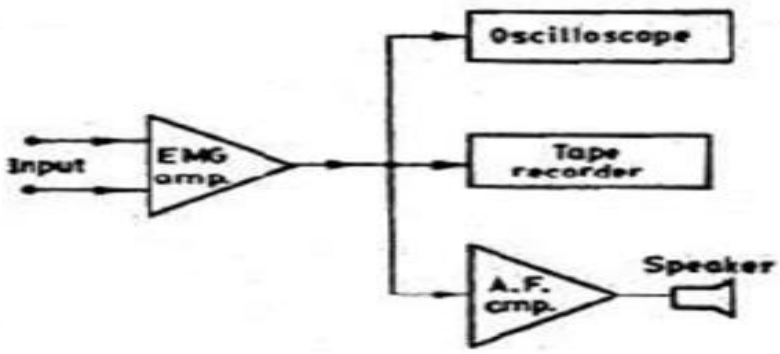
	as a result of the moving blood cells , the reflected signal has a different frequency due to the Doppler effect . Its frequency is either $F + F_D$ or $F - F_D$, depending on the direction of the flow. The Doppler component F_D is directly proportional to the velocity of the flowing blood.		
d)	**Enlist technical specifications of X-ray machine.**		**04**
Ans.	Input – 220 V AC ,50 Hz Capacity > 5 KV, 0.5 Ω Maximum output power – 4 KW mA adjusting range – 36 mA – 70 mA KV setting range -40 – 100 KV	**01-mark each for relevant specification**	
e)	**Describe electrode electrolyte interface with neat diagram.**		**04**
Ans.	 **Electrode-electrolyte interface** - The current crosses it from left to right. The electrode consists of metallic atoms C. The electrolyte is an aqueous solution containing cations of the electrode metal C + and anions A- .  Equivalent circuit for a bio potential electrode in contact with an electrolyte E_{hc} is the half-cell potential, R_d and $C_d$make up the impedance associated with the electrode-electrolyte interface, and	**Diagram-01 marks** **Description-03 marks**	

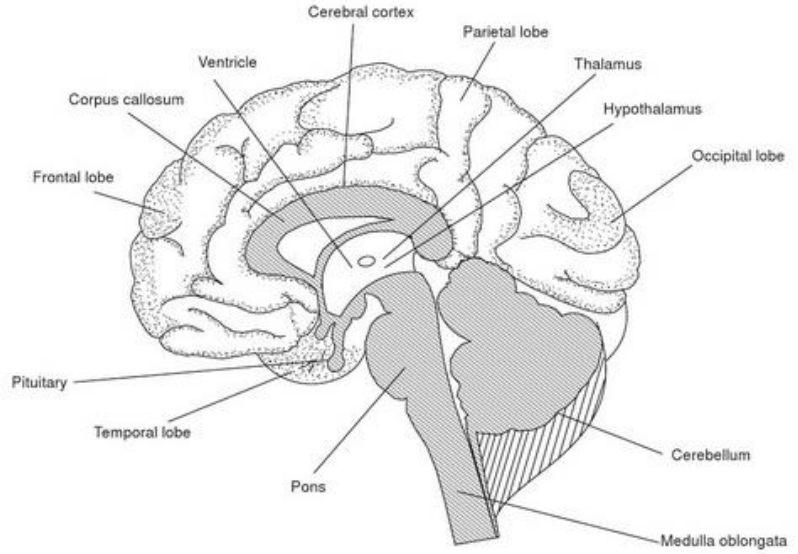
	Rs is the series resistance associated with interface effects and due to resistance in the electrolyte. E_{hc} is the potential developed at the electrode /electrolyte interface. The value of it depends on the species of metal and the type of electrolyte, its concentration and temperature. **Note: Any relevant electrode/electrolyte interface with neat diagram may consider.**		
4	**Attempt any THREE of the following**		**12**
(i)	**Define the following:** **1) Plethysmograph** **2) Phonocardiograph** **3) Pacemaker** **4) Defibrillator**		**04**
Ans.	**1) PLETHYSMOGRAPH-** Instruments measuring volume changes or providing outputs that can be related to them are known as plethysmographs. **2) PHONOCARDIOGRAPH-** A device use to plot a high-fidelity recording of the sounds and murmurs made by the heart is called the phonocardiograph. **3) PACEMAKER –** A device capable of generating artificial pacing impulses and delivering them to heart is known as pacemaker. **4) DEFIBRILLATOR –** A device used to control heart fibrillation by application of an electric current to the chest wall or heart is known as defibrillator.	**01 mark- each definition**	
(ii)	**Draw the different waveforms of EEG. Describe the various stage of sleep from it.**		**04**

Ans.	 **VARIOUS STAGES OF SLEEP FROM WAVEFORM** 1) BETA WAVES (14 TO 3 HZ) – Awake with mental activity 2) ALPHA WAVES (8 TO 13 HZ) – Awake and resting 3) THETA WAVES (4 TO 7 HZ) - Sleeping 4) DELTA WAVES (.5 TO 3 HZ)–Deep sleep	**02 marks for waveform(any four)** **½ mark for each**	
(iii)	**Explain microshock and macroshock with patient safety in brief.**		**04**
Ans.	**Microshock:** When an interaction of electric current takes place with human body or human body tissues in such a way that one contact is applied directly to the heart & other to body surface, the effect of current applied to the heart is often referred to as microshock. **Macroshock:** When an interaction of electric current takes place with human body or human body tissues in such a way that current applied to the surface contacts, the effect of current applied to the heart is called as macroshock. **Microshock & Macroshock with respect to patient safety:** Electrical accidents are caused by the interaction of electric current with the tissues of the body. For an accident to occur, current of sufficient magnitude must flow through the body in such a way that	**01 mark** **01 mark** **02 marks for safety**	

	it impairs the functioning of vital organ. The physiological effects of the current depend not only on their magnitude but also on the current pathway through the body, which in turn depends on the location of the two contacts.		
(iv)	**List different blood pressure measurement method. List standard values of:** **1) Systollic pressure** **2) Diastollic pressure**		**04**
Ans.	**Blood pressure measurement methods**: **1)** Indirect method Sphygmomanometer **2)** Direct method a) Percutaneous insertion b) Catheterization(vessel cut down) c) Implantation of a transducer in a vessel or in the heart. **Systolic blood pressure:** Range of systolic blood pressure in normal adult is in the range of 95-140 mm of Hg with 120 mm of Hg being average. **Diastolic blood pressure:** Range of Diastolic blood pressure in normal adult is in the range of 60-90 mm of Hg with 80 mm of Hg being average.	**02 marks for blood pressure measurement method(any two)** **01 mark** **01 mark**	
b)	**Attempt any ONE of the following**		**06**
(i)	**Describe the working of dialysis machine with neat diagram.**		**06**
Ans.	**Block diagram of dialysis machine**  **OR**	**03 marks-diagram**	

	 **Description** Dialysis machine works as artificial kidney which has following parts, 1. Dialyzer- This is the part in which blood filtration actually takes place and urine is formed. 2. Proportionating Pump- It produces steady flow of quality dialysate by having proper proportion of water and concentrated chemical. 3. Dialysate temp Control - To achieve dialysis at body temperature the control of temperature is essential. 4. Heparin infusion- It is done in order to avoid coagulation or clotting of blood, which is taken from the patient. 5. Venous pressure gauge - It monitors the pressure of blood which is given back to the patient. 6. Air/Foam Detector- It detects the presence of air / Foam in the blood to avoid danger. 7. Blood leak detector - It detects the leakage of blood from the dialyzer 8. Bypass circuit and line in clamp-: It is used to bypass the dialysate flow, for replacement, maintenance or repair of dialyzer.	**03 marks- Description**	
(ii)	**Draw the neat diagram of EMG. State functions of its component.**		**06**
Ans.			

	EMG  Electromyograph is an instrument used for recording the electrical activity of the muscle to determine whether the muscle is contracting or not; or for displaying on the CRO and loudspeaker. The block diagram shows set up for EMG recordings 1) EMG is usually recorded by using surface electrodes or more often by using needle electrodes, which are inserted directly into the muscle. The surface electrodes may be disposable, adhesive types or the ones which can be used repeatedly. A ground electrode is necessary for providing a common reference for measurement. 2) These electrodes pick up the potentials produced by the contracting muscle fibres. 3) The signal then can be amplified and displayed on the screen of a CRO. 4) It is also applied to an audio amplifier connected to loud speaker 5) A trained EMG interpreter can diagnose various muscular disorders by listening to the sounds produced when the muscle potentials are fed to the loudspeaker.	**02 marks-diagram** **04 marks-Description**	
5	**Attempt any TWO of the following**		**16**
a)	**Draw a neat labeled diagram of human brain structure. Describe its working in detail.**		**08**
Ans.	**Structure of brain:**	**04 marks**	



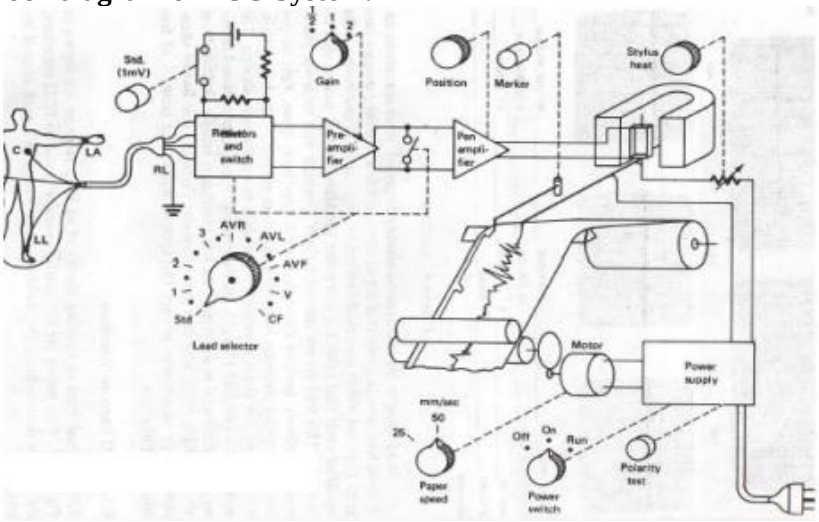
Cut-away section of the human brain

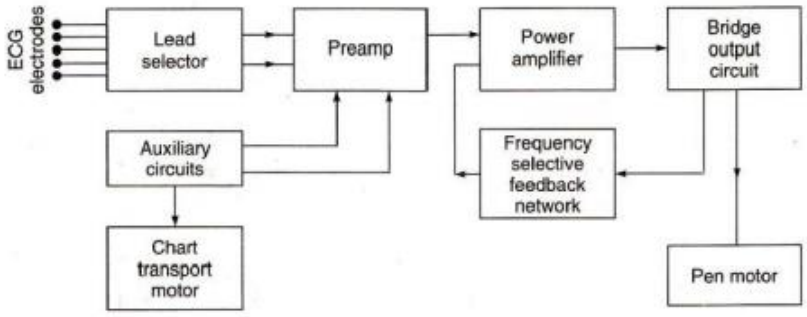
for neat labeled Diagram,

Description:

04 marks- for relevant Description

- The brain consists of three parts cerebrum, cerebellum and brain stem.
- **Cerebrum** divided into two hemispheres right & left. These hemispheres are subdivided into frontal & temporal lobe in left and parietal & occipital in right hemisphere.
- The frontal lobes are essential for intelligence, constructive imagination & thought. Large quantities of information stored temporarily & correlated thus making basis of higher mental functions.
- Parietal lobe -In the anterior part of parietal lobe lies the terminal station for nerves pathways conducting sensation from the opposite half of the body.
- Occipital lobe – visual pathways terminate in the posterior part of the occipital lobe. The rest of the occipital lobes store visual memories by means of which we interpret what we see.
- Temporal lobe – on the upper side of temporal lobe, the acoustic pathways terminate making it as a hearing centre. This is located just above the ears. The temporal lobes are also of importance for the storage process in the long term memory.
- The outer layer, cerebral cortex, is the centre of intellectual functions. The inputs from sensors reach to cortex. Certain regions relates to certain modalities of sensory information like hearing, sight, touch & control of voluntary muscles. The sensory information come from the legs, the torso, arms, hands, fingers, face, throat etc.
- The **cerebellum** (Latin for *little brain*) is a region of the brain that plays an important role in motor control. It enables a person to maintain his balance.
- The cerebellum acts as a physiological microcomputer which intercepts various sensory & motor nerves to smooth out the

	muscle motions which could be otherwise jerky. • It also consists of two hemispheres which regulate the coordination of muscular movements elicited (call forth) by the cerebrum. • It may also be involved in some cognitive functions such as attention and language, and in regulating fear and pleasure responses, but its movement-related functions are the most solidly established. • It receives input from sensory systems of the spinal cord and from other parts of the brain, and integrates these inputs to fine tune motor activity. • The **brain stem** connects the spinal cord to the centre of the brain just below the cerebral cortex. It is the posterior part of the brain. • The brain stem provides the main motor and sensory innervations to the face and neck via the cranial nerves. • Though small, this is an extremely important part of the brain as the nerve connections of the motor and sensory systems from the main part of the brain to the rest of the body pass through the brain stem. • This includes the corticospinal tract (motor), the posterior column-medial lemniscus pathway (fine touch, vibration sensation and proprioception) and the spinothalamic tract (pain, temperature, itch and crude touch). • The brain stem also plays an important role in the regulation of cardiac and respiratory function. It also regulates the central nervous system, and is pivotal in maintaining consciousness and regulating the sleep cycle. The brain stem has many basic functions including heart rate, breathing, appetite, thirst, sex drive, sleeping.		
b)	**Draw a neat labeled diagram of ECG system. State function of its different component.**		**08**
Ans.	**Block diagram of ECG System:**  OR	**04 marks-Diagram**	



Explanation:

This system is used to plot a ECG waveform.

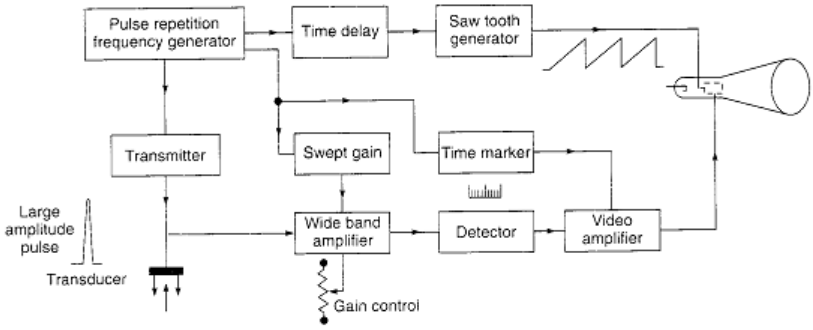
- The leads are used for connecting electrode o/p to recorder system.
- Lead selector switch: This is used to select type of lead connection like Lead I, II , III or AVL , AVF or AVR and chest lead type connection. The wires from the electrodes are connected to the lead selector switch, which also incorporates the resistors necessary for lead configuration.
- A push button (Calibrator push Button): It produces standardization voltage of 1mV to calibrate ECG recorder. The signals from lead switch goes to preamplifier.
- Preamplifier: it is differential amplifier with high gain & CMRR . It is ac coupled to avoid problems with small dc voltages. These small voltages originate from polarization of the electrodes. This preamplifier is also provided with gain setting facility, so that gain of amplifier can be adjusted.
- Pen drive Amplifier: The o/p of preamplifier is given to dc amplifier. This dc amplifier is called as Pen drive amplifier. This provides power to drive the pen motor that records the actual ECG waveform.
- Position control: This ckt controls the pen amplifier gain so that pen is at center of recording paper.
- Stylus (pen) control ckt: As modern recorder uses heat sensitive paper so temperature of ink in stylus (pen) is controlled by this ckt. This gives optimum recording on paper.
- Marker Stylus ckt: This repositions marker stylus at marginal side. This marker stylus marks coded indication of lead being connected by lead selector switch.
- Recording paper driving system: The paper is moved at regular speed by motor connected to rollers. Recording paper is rolled on these rollers. Speed of paper is 25mm / sec faster speed is of 5o mm / sec is provided to allow better resolution of QRS complex at more heart rate.

Or

Note: Any relevant block diagram with explanation may be considered.

04 marks- Explanation

c)	**Describe working of ultra sonography imaging technique of human**		**08**

	body with neat diagram. Enlist its technical specification. (any four)		
Ans.	**Diagram:**  *Block diagram of a basic pulse-echo system* **working:** • The transmitter generates a train of short duration pulses at a repetition frequency determined by PRF generator. These are converted into corresponding pulses of ultrasonic waves by piezoelectric crystal i.e. transmitting transducer. • The echoes from the target or discontinuity are picked up by the same transducer and amplified suitably for display on a cathode ray tube. • The probe i.e. the transducer consists of a piezoelectric crystal which generates and detects ultrasonic pulses. • Transmitter: the transmitting crystal is driven by a pulse from the PRF generator and is made to trigger an SCR circuit which discharges a capacitor through the piezoelectric crystal in the probe to generate an ultrasonic signal. • Pulse repetition Frequency generator produces a train of pulses which control the sequence of events in the rest of the equipment. It is usually kept between 500Hz to 3KHz • Receiver: the function of the receiver is to obtain the signal from the transducer and to extract from it the best possible representation of an echo pattern. To avoid significant worsening of the axial resolution, the receiver bandwidth is about twice the effective transducer bandwidth. • Wide Band amplifier: The echo signals received at the receiving transducer are in the form of modulated carrier frequency and may be as small as a few microvolts. These signals require sufficient amplification before being fed to a detector circuit for extracting modulating signals. This is achieved by wide band amplifier. • Swept Gain Control: stronger echoes are received from the more proximal zones under examination than from the deeper structures. The receiving amplifier can only accept a limited range of input signals without overloading and distortion. Abrupt changes in tissue properties that shift the acoustical impedance can cause the echo amplitudes to vary over a wide dynamic range, perhaps 40 to 60 dB. In order to avoid this , the amplifier gain is adjusted to compensate for these variations. • Detector: after the logarithmic amplification the echo signals are	**03 marks-Diagram** **03 marks-Working**	

	rectified in the detector circuit. This is followed by the demodulating circuit in which the fundamental frequency signal upon which the echo amplitude information has been riding, is eliminated and gives the actual echo signal. • Video Amplifier: The output of demodulator circuit is around 1V, but for display on CRT, it must be amplified to 100- 150V. Hence RC coupled video amplifier is used. • Time Delay Unit: In some cases, the start of the trace can be delayed by the time delay unit so that the trace can be expanded to obtain better display and examination of a distant echo. • Time Base: the time base speed is adjusted so that echoes from the deepest structures of interest will appear on the screen before the beam has completely traversed. • Time Marker: the time marker produces pulses that are a known time apart and, therefore, correspond to a known distance apart in human tissues. These marker pulses are given to the video amplifier and then to the Y plates for display along with the echoes. **Specifications:** • Applications : abdominal, obstetric/ gynaec, small parts, musculoskeletal, TCD, vascular, cardiac. • Monitor Type: CRT/ LCD • 2D frame Rate: upto 500 frames per second • Display depth: upto 35cm • Dynamic range: at least 170dB to pick up subtle echoes. • Transducer Frequency: 1-12MHz. • TGC and Receiver Gain: button control for automatic optimization & adjustment. • Modes: B, 2B, 4B, 2D, M-mode, Colour M-mode, Colour flow, Pulse Wave Doppler, and Colour Power Doppler. • Cine Function : Cine Review upto 1200 frames, Independent Cine Review in 2D/M, 2D/Doppler, 2D/C/Doppler, etc.	**02 marks- (Any 4 specifications)**	
6	**Attempt any FOUR of the following**		**16**
a)	**Explain the meaning of different heart sound generated in human body.**		**04**
Ans.	The principle cause of heart sound seems to be vibrations set up in the blood inside the heart by the sudden closure of the heart valves. • **First heart sound**: it is also called as "lub" sound is caused due to the closure of the atrioventricular valves, which permits flow of blood from the atria in to the ventricles but prevent flow in reverse direction. • **Second heart sound**: it is also called "dub" sound is caused due to the closing of semi lunar valves. • **Third heart sound**: occurs from 0.1 to 0.2 seconds after the second heart sound is due to rush of blood from the atria into the ventricles, which causes turbulence and some vibration of ventricle walls • **Atrial heart sound**: It is not audible but may be visible on a graphic	**04 marks for (any four) heart sound**	

recording, occurs when the atria actually do contract, squeezing the remainder of the blood into the ventricles.

- **Murmurs**: In abnormal heart additional sound called murmurs, are heard with a normal heart sound. They are generally caused either by improper opening of valves when the valves do not closed completely and allow some backward flow of blood. In either case the sound is due to high velocity blood flow through the small opening.

b) Compare internal & External Pacemaker. (any four points) — **04**

Ans. — **04 marks- Any 4 points**

Internal Pacemaker	External pacemaker
i) Entire system (electrodes and pulse generator) is implanted inside the body.	i) In this electrodes are placed inside the body and pulse generator is implanted outside the body.
ii) It is used on patient having permanent heart block	ii) It is used on patient having temporary heart irregularities.
iii) The electrodes used are myocardial type	iii) The electrodes used are endocardial type
iv) Battery replacement needs minor surgery	iv) Battery replacement is easy and doesn't need surgery
v) It requires an open surgery to place the generator	v) It doesn't requires an open surgery
vi) It is protected from external disturbances	vi) Not protected from external disturbances
vii) Small in size	vii) Large in size

c) List precautions to be taken to minimise electric shock hazard and leakage current in hospitals. (any eight) — **04**

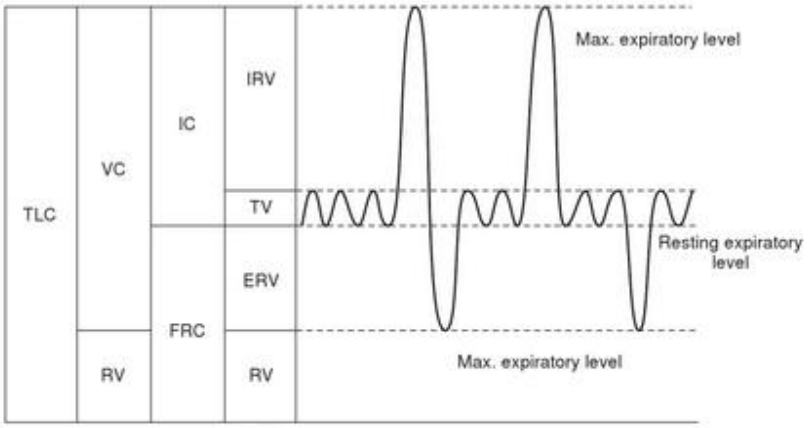
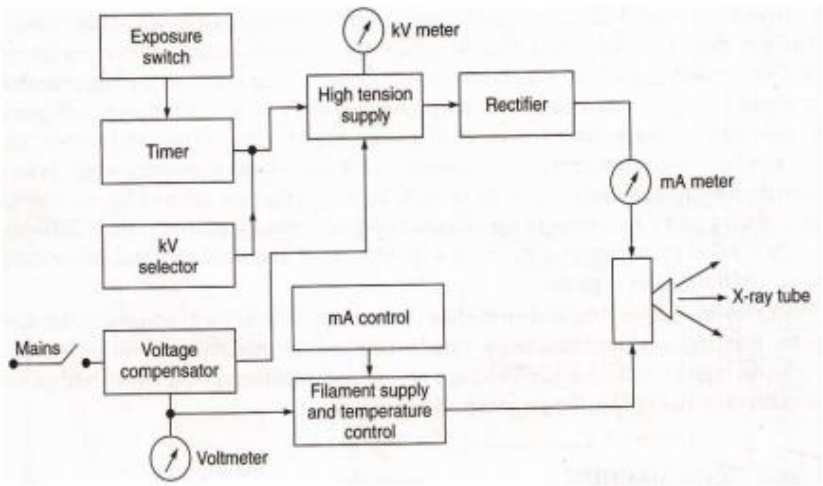
Ans. — **04 marks- (Any eight points)**

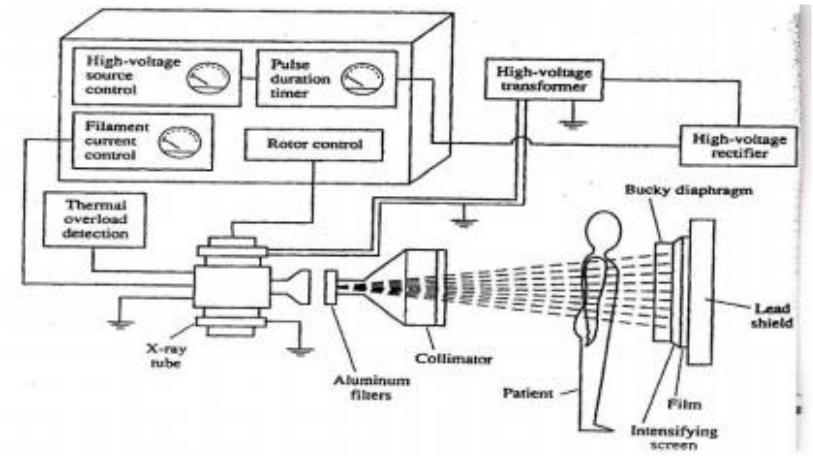
Precautions to minimize electric shock hazards and leakage current in hospitals:

- In the vicinity of the patient, appliances with three wire power cords should be used.
- Provide isolated input circuits on monitoring equipment.
- Have periodic checks of ground wire continuity of all equipment.
- Connectors for probes and leads should be standardized so that current intended for powering transducers are not given to the leads applied to pick up physiologic electric impulses.
- Ground fault circuit interrupters should be used to disconnect the source.
- Reducing leakage current inside the chassis of instruments by using layout.
- The solid state electronic diagnostic equipment to be so selected that they work on low voltage.
- A separate (double) secondary layer of insulation between the chassis and the outer case is provided to protect personnel from ground fault.
- Double insulation reduces leakage current and also protects against both Macro shock and Micro shock.

d) Draw neat waveforms indicating lung volume and capacities. Explain — **04**

	their meaning in brief.		
Ans.	**Lung volume and capacities:** **Explanation:** Measurement of lung volumes provides a tool for understanding normal function of the lungs as well as disease states. In normal breathing at rest, approximately one-tenth of the total lung capacity is used. The following terms are used to describe lung volumes & capacities. **Lung Volumes:** **Tidal Volume (TV):** The volume of gas inspired or expired (exchanged with each breath) during normal quiet breathing. **OR** The volume of air breathed in and out without conscious effort. **Minute Ventilation:** The volume of gas exchanged per minute during quiet breathing. MV=TV x Breathing rate **Alveolar Ventilation(AV):** the volume of fresh air entering the alveoli with each breath. Alveolar Ventilation=breathing rate X (Tidal volume-Dead space) **Inspiratory Reserve Volume (IRV):** The volume of gas which can be inspired from a normal end. **OR** The additional volume of air that can be inhaled with maximum effort after a normal inspiration. **Expiratory Reserve Volume (ERV):** The volume of gas remaining after a normal expiration less the volume remaining after a forced expiration. ERV=FRC-RV **OR** The additional volume of air that can be forcibly exhaled after normal exhalation **Residual Volume (RV):** The volume of air remaining in the lungs after maximum exhalation or forced expiration. **Lung Capacities:** **Functional Residual Capacity:(FRC)** The volume of gas remaining in the lungs after normal expiration. **Tidal Lung Capacity:(TLC)** The volume of gas in the lungs at the point of maximum inspiration. TLC=VC+RV **Vital Capacity (VC):** The greatest volume of gas that can be inspired by voluntary effort after maximum expiration irrespective of time. **OR** The total volume of air that can be exhaled after a maximum inhalation: VC = TV + IRV + ERV **Inspiratory Capacity:** The maximum volume that can be inspired from the resting end	**01 mark-Lung Volumes(any two)** **01 mark-Lung capacities(Any two)**	

	expiratory position. **Dead Space:** It is the functional volume of the lung that doesn't participate in gas exchange. Total Lung Capacity (TLC):TLC= VC + RV  Figure: Lung Volumes and Lung Capacities	**02 marks- Diagram**	
e)	**Draw neat diagram of X-ray machine. Describe its working.**		**04**
Ans.	 **OR**	**02 marks- Diagram**	

	 **Explanation :** X ray machine has two parts of the circuit. i) One of them is to produce high voltage which is applied to tubes anode and cathode and comprises high voltage step up transformer followed by rectification. The current through the tube follows the high tension path way and is measured by mA meter. A kV selector switch facilitates change in voltage between the exposures. The voltage is measured with the help of kV meter. The exposure switch controls the timer and thus the duration of application of kV. To compensate mains supply voltage variation a voltage compensator is included in the circuit. ii) Second part concerned the heating X-Ray tube filament; the filament is heated with 6-12 volts of AC Supply at current of 3-5 A. The filament temperature determines the tube current and therefore the filament temp control is attached with millimeter selector. The filament current is controlled by using in the primary side of the filament transformer, a variable choke or rheostat. The rheostat provides a step wise control of mA and is most commonly used in modern machine. A preferred method of providing high voltage dc to the anode of X-Ray tube is by use a bridge rectifier using 4 valve tube or solid state rectifiers, which provide more efficient system than the half wave self rectification method	**02 marks-Explanation**	
f)	**Enlist technical specifications of defibrillator. (any four)**		**04**
Ans.	**Specifications of DC Fibrillator:** • Operating mode: semi automatic. • Waveform: e~cube Biphasic (BTE type). • Energy: Adult-150 J into a 50Ω load (default setting), Pediatric-50J. • Pre-programmed selection (150 J-150 J-150 J, 150 J-150 J-180 J, 150 J-180 J-180 J). • Charging time: Less than 10 seconds. • Sensitivity & Specificity: Meets AAMI guidelines. • Detection Level: >0.1 mV ECG. • Defibrillation Electrodes: multifunctional electrodes (disposable) adult adhesive pads (pre-gelled)	**04 marks-(Any 4 specifications)**	