MODEL ANSWER

SUMMER– 19 EXAMINATION

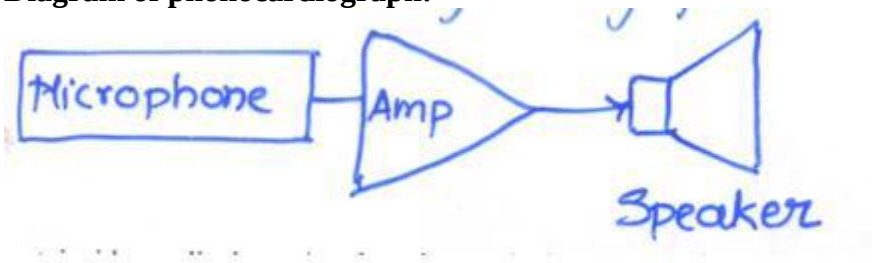
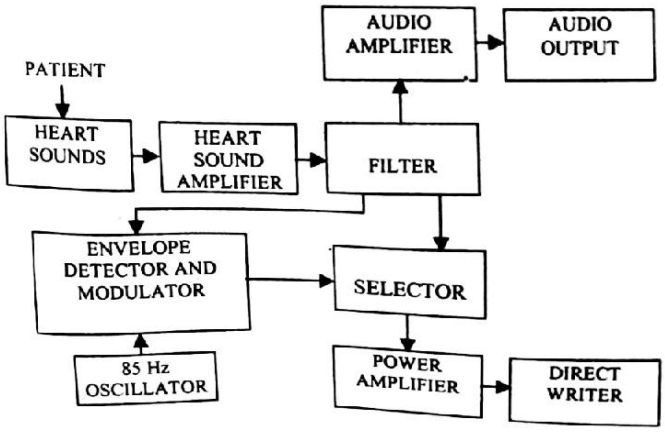
Subject Title: Biomedical Instrumentation Subject Code: 17666

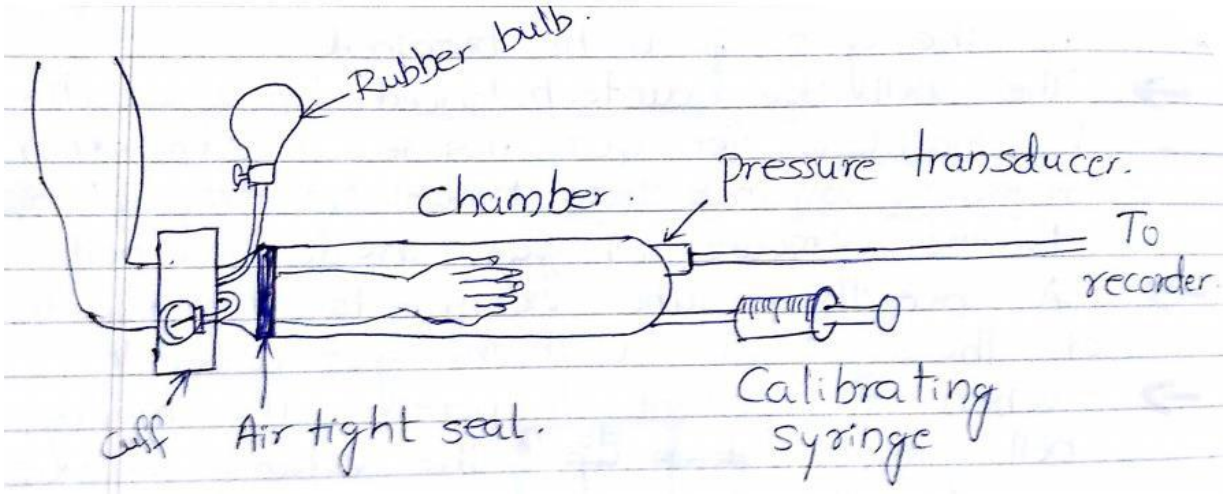
Important Instructions to examiners:

1) The answers should be examined by key words 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 anyequivalent 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.

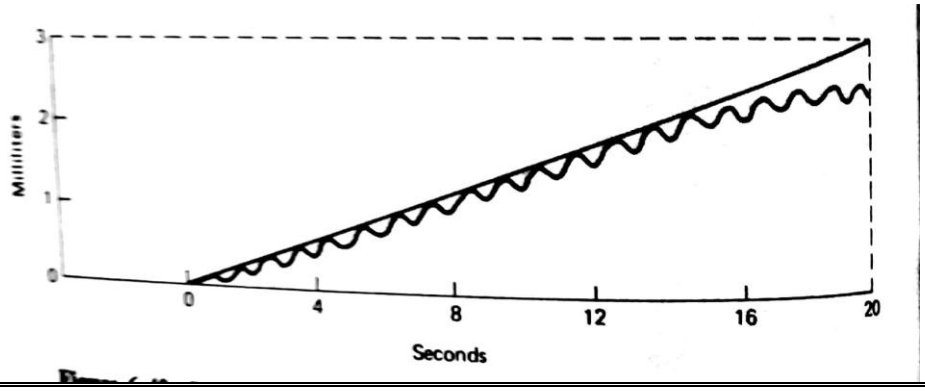
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	**a)**	**Attempt any THREE of the following**	**12 M**
	i)	**State any four functions of kidney.**	**4 M**
	Ans.	The various functions of kidney are as follows: i) Primary function is to form urine out of blood plasma. ii) Removal of waste products of metabolism like urea, uric acid, creatinine, etc. iii) Regulation of composition of blood plasma. iv) To maintain osmotic pressure v)to maintain pH & electrolyte composition of extra cellular blood fluids vi) Regulation of acid-base balance. vii) Removal of excess of foreign substances like drugs and pigments in the body. viii) It is responsible for maintaining the internal environment constant and balanced. This is called homeostasis.	**01 Mark for each Any four functions**
	ii)	**List the specifications of DC fibrillator.**	**4 M**
	Ans.	**Specifications of DC Fibrillator: (any Four)**	

		• Type of electrodes: Paddle electrodes • Operating mode: semi automatic. • Waveform: e ~ cube Biphasic (BTE type). • Energy: 150 J into a 50Ω load (default setting). • 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) **Note**: Any other relevant technical specifications can also be given marks.	**01M each**
	iii)	**Compare internal and external pacemaker (any four points)**	**4 M**
	Ans.	<table><tr><th>Internal Pacemaker</th><th>External pacemaker</th></tr><tr><td>i) Entire system (electrodes and pulse generator) is implanted inside the body.</td><td>i) In this electrodes are placed inside the body and pulse generator is implanted outside the body.</td></tr><tr><td>ii) It is used on patient having permanent heart block</td><td>ii) It is used on patient having temporary heart irregularities.</td></tr><tr><td>iii) The electrodes used are myocardial type</td><td>iii) The electrodes used are endocardial type</td></tr><tr><td>iv) Battery replacement needs minor surgery</td><td>iv) Battery replacement is easy and doesn't need surgery</td></tr><tr><td>v) Small in size</td><td>v) Large in size</td></tr><tr><td>vi) It requires an open surgery to place the generator</td><td>vi) It doesn't requires an open surgery</td></tr><tr><td>vii) It is protected from external disturbances</td><td>vii) Not protected from external disturbances</td></tr></table>	**(Any 4 points 1 M)**
	iv)	**Explain with neat diagram the working of phonocardiograph.**	**4 M**
	Ans.	**Explanation:** The instrument used for graphically recording heart sound is called phonocardiograph. A graphic record of heart sounds is called phonocardiogram. The basic transducer for the phonocardiogram is a microphone having necessary frequency response ranging from 5 Hz to above 1000Hz. An amplifier with similar response characteristics is required which may offer a selective low pass filter to allow the high frequency cut off to be adjusted for noise. The readout of a phonocardiograph is either a high frequency chart recorder or an oscilloscope. Although the normal heart sounds fall within the frequency range of pen recorders, the high frequency murmurs that are often important in diagnosis require the grater response of phonographic device. Microphones for phonocardiograms are designed to be placed on the chest over the heart. Spectral display of heart sounds provides a useful diagnostic	**2M**

		tool that requires a high speed digital computer with analog to digital conversion capability. **Diagram of phonocardiograph:**  **OR** **Block diagram of PCG**  The input heart sound section receives the heart sound signals from the microphone placed on the patient's chest and feeds it to the heart sound amplifier. The heart sound preamplifier amplifies the heart sounds to the desired level. The audio amplifier and audio output section further amplify these sounds to drive the head phones. A five step filter is used to pass the selected band of heart sounds to the power amplifier. A direct writing hot stylus galvanometer is used to record heart sounds and murmurs whose frequency range is between 20Hz to2 KHz as a standard galvanometer can record frequencies below 100 Hz only. Here the signal envelope is detected and modulated with 85 Hz frequency generated by a85 Hz oscillator. The modulated signal has frequency component of 85Hz only and envelope of acquired heart sound. So the signal is recorded using hot stylus galvanometer	**2M** **2M** **2M**
	b)	**Attempt any ONE of the following**	**6 M**
	i)	**Draw and describe the blood flow measurement plethysmograph.**	**6 M**
	Ans.	**Diagram:**	**3M**

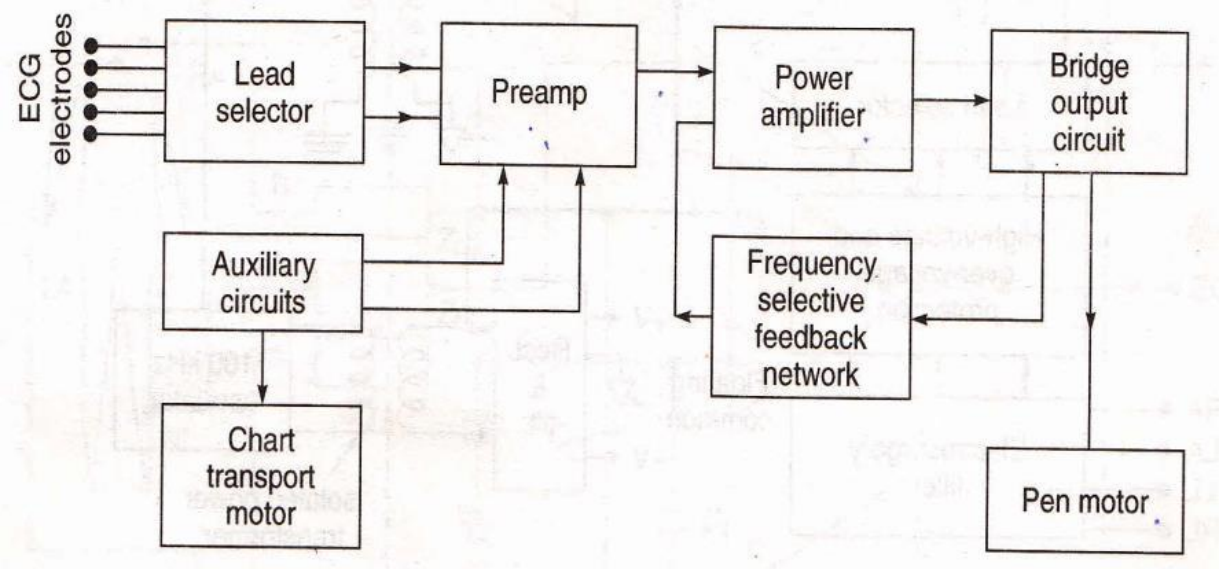


Explanation: The instrument used to measure blood volume changes and in turn blood flow is called as Plethysmograph. It consists of a rigid cup or chamber placed over the limb or digit in which volume changes are to be measured. The cup is tightly sealed the member so that any changes of volume in the limb or digit reflect as pressure changes inside the chamber. Either fluid or air can be used to fill the chamber. A pressure transducer is included to respond to pressure changes within the chamber and to provide a signal that can be calibrated to represent the volume of blood of the limb or digit. The base line pressure is calibrated using syringe. If the cuff placed upstream from the seal is not inflated, the output signal is a sequence of pulsations proportional to the individual volume changes with each heartbeat. If the cuff is inflated to a pressure just above venous pressure arterial blood can flow past the cuff but venous blood cannot leave. Due to this the limb or digit increases it's volume with each heartbeat by the volume of the blood entering during that beat. In this way total amount of blood flowing into the limb can be measured. The recording of Plethysmograph is as shown.



3M

ii)	**Define Electrocardiogram. Describe ECG with the help of block diagram.**	**6 M**
Ans.	**Definition**: Electrocardiogram is the recording of the bio potentials of the heart. **OR** ECG is recording of biopotential due to electrical activity of human heart. **Block Diagram:**	**1M**



2M

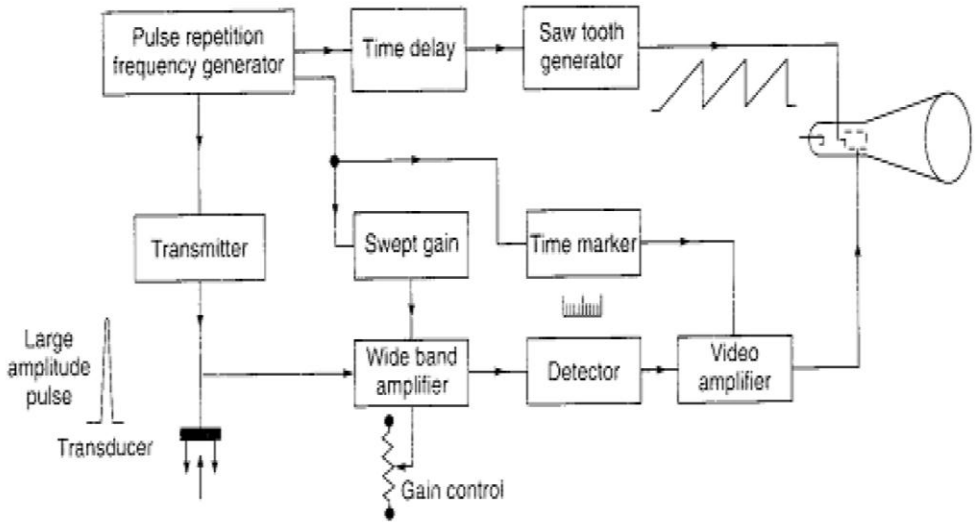
Description:

- The potential picked up by the electrodes are taken to the lead selector where lead whose output is required are selected as per lead wire configuration.
- By means of capacitive coupling the signal is connected to the differential preamplifier.
- The preamplifier is usually a 3 or 4 stage differential amplifier having sufficiently large negative current feedback.
- The amplified output signal is given to the power amplifier.
- The power amplifier is a push-pull type. The base of one input transistor is driven by pre amplified signal and the base of other is driven by feedback network.
- The output of power amplifier deflects the writing arm.
- Paper recording speed is 25 mm/s
- Amplitude measurements are made vertically made in mV
- Sensitivity of electrocardiograph is typically set to 10mm/mV

3M

It includes speed control circuit for a chart drive motor.

Q. 2.		**Attempt any Two of the following**	**16 M**
	a)	**Explain the working of ultrasonography imaging technique of human body with neat diagram. List its technical specification (any four points)**	**8 M**
	Ans.		



2M

1. Pulse repetition frequency generator: It produces a train of pulses which are applied to the transducer through the transmitter circuit. The PRF frequency is kept between 500Hz and 3KHz
2. Transmitter circuit: It receives pulses from the PRF generator and uses it to trigger an SCR present in the circuit. Due to this a capacitor present discharges through the piezoelectric crystal in the probe to generate an ultrasonic signal.

2M

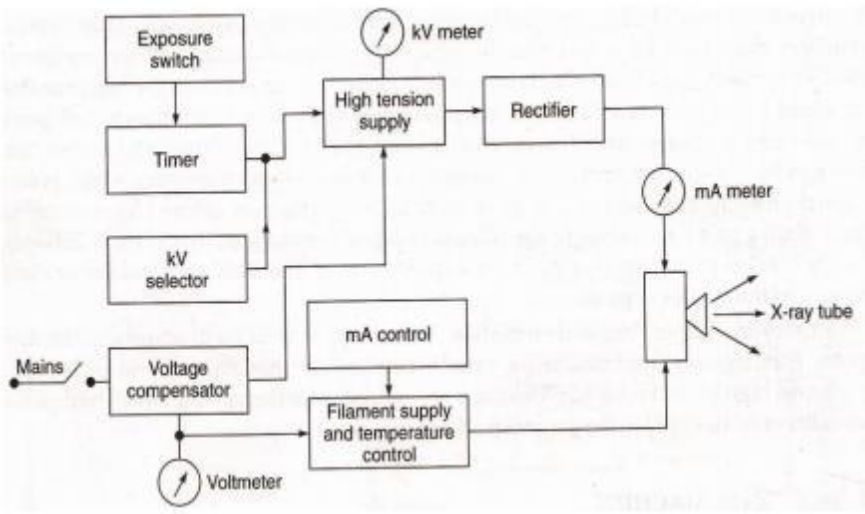
3. The probe : It consists of a transducer which is a piezoelectric crystal that generates and detects ultrasonic pulses. These pulses are applied to the body through the probe. After reflection the same crystal receives the reflected waves and converts them into equivalent electric signal.

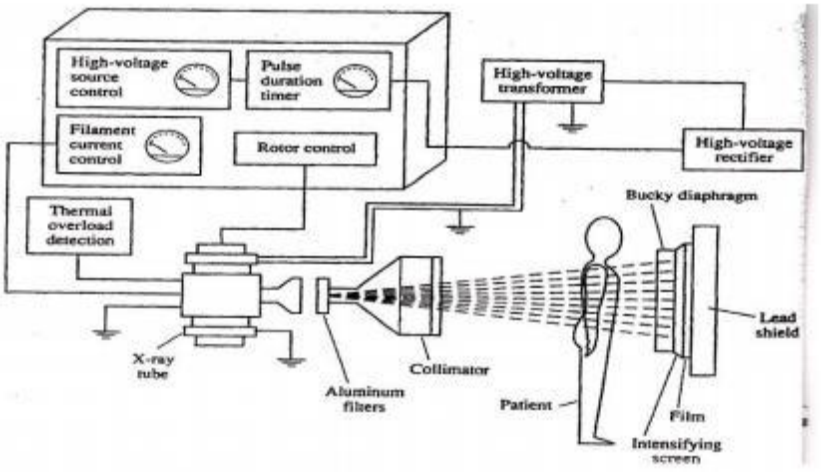
4. Wide Band amplifier: The echo signals received by the transducer are of carrier frequency and of a few microvolts. These signals require sufficient amplification before being fed to a detector circuit for extracting modulating signals. This is achieved by wide band amplifier.

5. Swept Gain Control: Stronger echoes are received from the surface structures than from the deeper structures. The swept gain control circuit is used to control the gain of amplitude of echo according to the depth of the echo producing target.It adjusts the gain such that the chosen target will produce a constant appearance of display independent of depth.

6. Detector: After the logarithmic amplification the echo signals are 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.

7. 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.

		8. 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. 9. 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 it. 10. 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 of Ultrasonographic Imaging Techniques:** • Applications: abdominal, obstetrics/ gynaecology, 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. **Note: any four relevent specifications other than the above can also be given marks.**	**4M**
	b)	**Draw block digram of X-Ray machine and explain its working**	**8 M**
	Ans.		**4M**

		OR  **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) X-Ray tube filament:The filament is heated with 6-12 volts of AC supply at a 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.	**4M**
C)		**Explain lung volumes and capacities with waveform.**	**8 M**
	Ans.	**Lung Volumes: (any THREE)** **Tidal Volume (TV):** The volume of gas inspired or expired (exchanged with each breath) during normal quiet respiration cycle. **OR** The volume of air breathed in and out without conscious effort. **Minute Ventilation or Respiratory minute volume (MV):** The volume of gas exchanged per minute during quiet breathing. MV=TV x Breathing rate **OR** The amount of air inspired during one minute at rest. **Alveolar Ventilation (AV):** the volume of fresh air entering the alveoli with each breath. Alveolar Ventilation=breathing rate X (Tidal volume-Dead space)	**01 mark for each term of lung volume**

Inspiratory Reserve Volume (IRV):
The volume of gas which can be inspired from a normal end.

OR

The additional volume of air that a person can inspire with maximal effort after reaching the normal end inspiratory level.

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: (any FOUR)

Functional Residual Capacity:(FRC)
The volume of gas remaining in the lungs after normal expiration.

Total Lung Capacity:(TLC)
The volume of gas in the lungs at the end 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

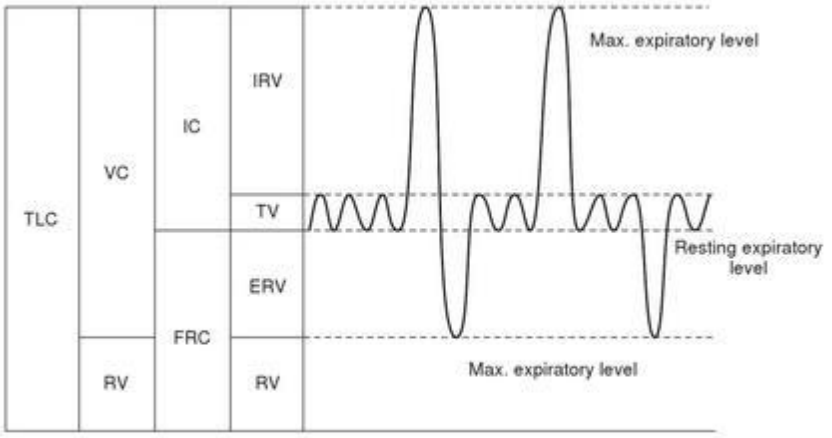
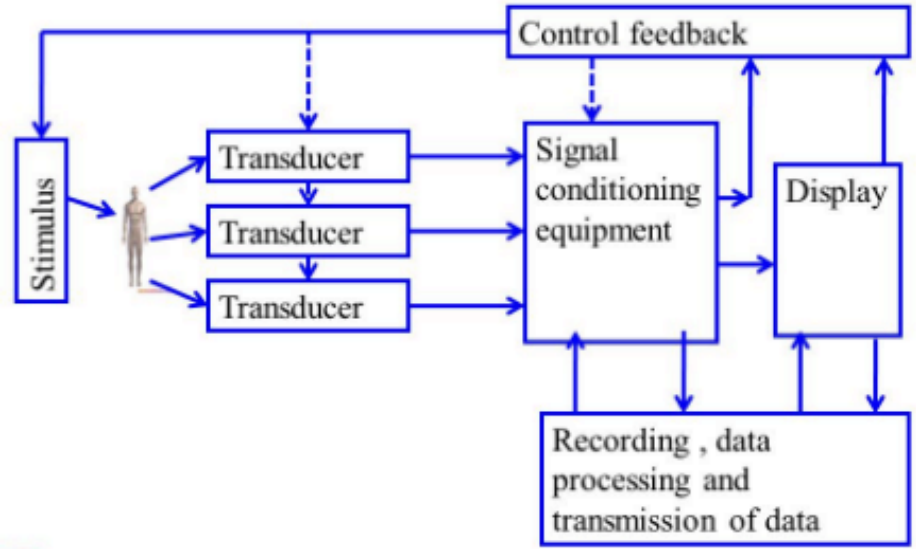
The maximum volume of air that can be expelled from the lungs by forceful effort after a maximum inspiration:
VC = TV + IRV + ERV

Inspiratory Capacity:
The maximum volume of air that can be inspired after reaching the end expiratory level.

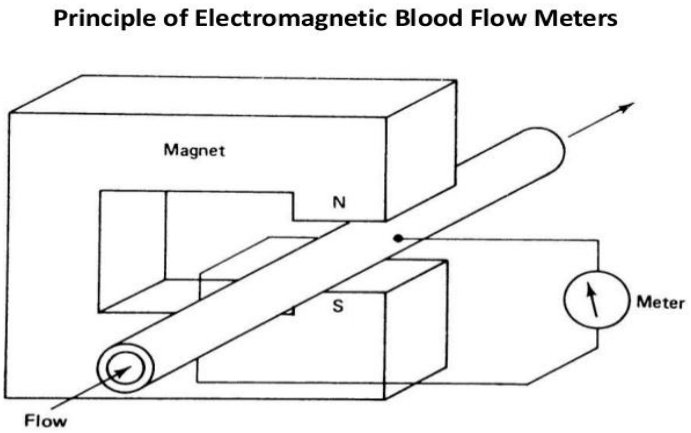
Dead Space:
It is the functional volume of the lung that doesn't participate in gas exchange.

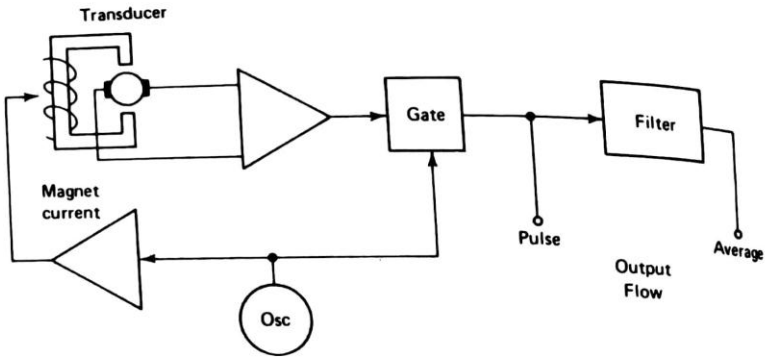
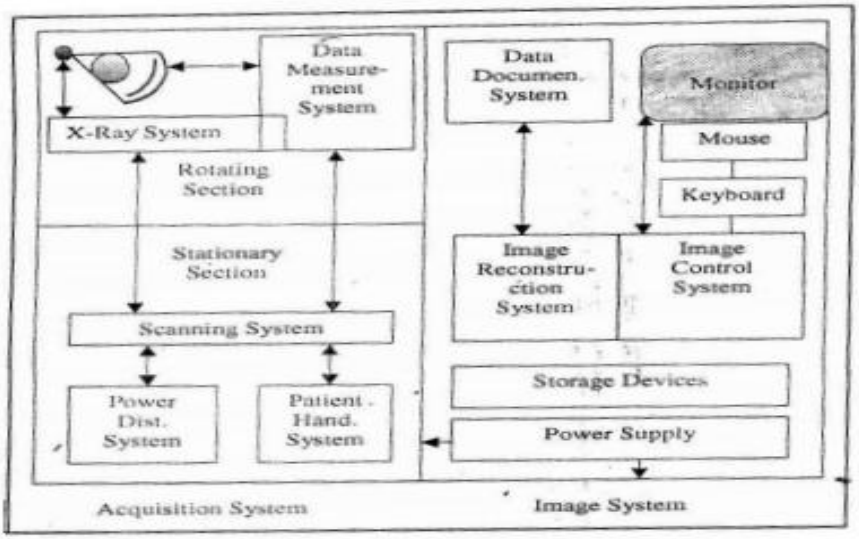
Total Lung Capacity (TLC):TLC= VC + RV

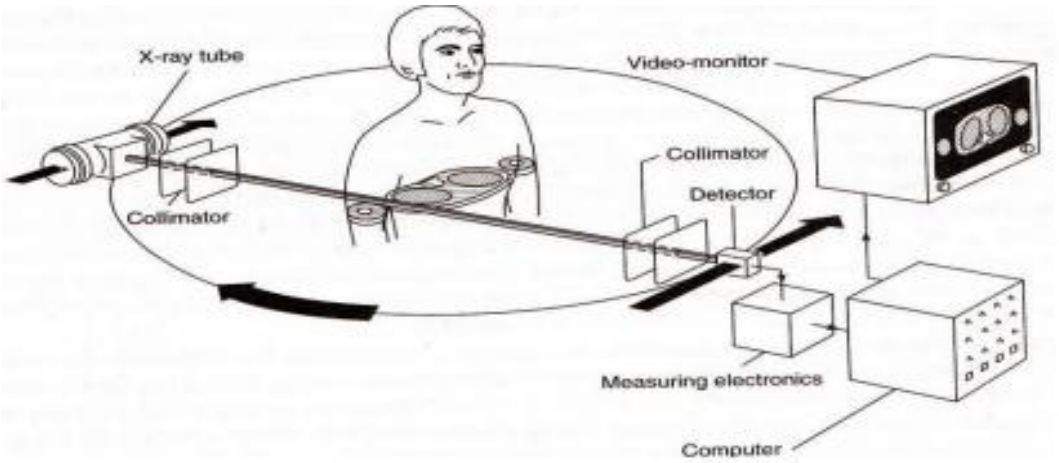
01 M for each term of lung capacity

		 ➢ Fig. *Volume and capacities of the lungs-standardization of definitions and symbols in respiratory physiology*	**2 M for wavef orm**
Q. 3.		**Attempt any FOUR of the following**	**16**
	a)	**Draw the block diagram of man- instrument system and state the function of any two components**	**4 M**
	Ans.	**Block diagram of man-instrument system :**  **Explanation:** The basic components of the man instrument system are: 1. Subject: The subject is the human being on whom the measurements are made. 2. 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 measured. E.g. visual (flash of light), auditory (a tone), etc.	**2M** **2M for functi ons of any two block**

		3. Transducer: In Man Instrument system, the transducer is used to produce an electrical signal that is an analog of the phenomenon being measured. 4. Signal conditioning equipment: This part of the system amplifies, modifies, or in any other ways changes the electric output of the transducer in order to satisfy the functions of the system and to prepare signals suitable for operating the display or recording equipment that follows. 5. 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 of the human senses in a meaningful way. E.g. graphic pen recorder for recoding ECG signal. 6. Recording, Data processing, and Transmission: Recording instruments are required to record the desirable information that can be used to transmit from one location to another or for possible later use. E.g. a). An online digital computer is used when automatic storage or processing of data is necessary, b) Recording equipment etc. 7. 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.	
	b)	**List the technical specification of X-Ray amchine.**	**4 M**
	Ans.	**(Marks to be given for any four relevent specifications other than mentioned below)** 1. **X-Ray Generator** : • The high power R/F system should have high frequency (50000 pulses or more) inverter type generator. • 32kW High voltage generator with inverter frequency and Maximum output of 32kW. • Radiographic kV range: 40-125 kV. • Maximum mA: 300mA or higher. • Radiographic exposure time range: 5msec to 1 Sec. **2. 2 Radiographic table.** • 5 Position manual operation patient table • Table tilt: (+) 90 degree – (-) 12 degree. • Cassette / Film size: 8 × 10 inch, 14 × 17 inch, 12 × 15 inch. • 4 X-Ray Grid: 8:1, 100 lines/cm. **3. X-Ray Tube** • Min 115 KHU – BHEL / Toshiba / Varian Tube. • High speed rotating anode tube of 2800 rpm or better. • Dual focal spot. - Small focus – not more than 1.2mm. - Large focus - not more than 2.0mm. • Short term rating – 20 kW / 40kW or better. 3.5 HT Cable pair 10m or more. **4. Accessories**	**1M Each**

	• Lead aprons, thyroid &pelvic guards with each unit. • Chest stand should be provided to do radiography without grid. • The unit should be provided with vertical Bucky. • It should be provided with a removable GRID of 8:1 ratio (minimum) & focus distance of 180cm. 5. **Power Requirements**. • Phase AC Supply, 50 Hz, Line Resistance ≤0.3 Ω. • Power Consumption not more than 25 kVA.	
c)	**Draw and desribe electromagnetic type blood flow measurement method**	**4 M**
Ans.	**Diagram:**  	**2M**
	Working principle: • Measures instantaneous pulsatile flow of blood • Works based on the principle of electromagnetic induction. • The voltage induced in a conductor moving in magnetic field is proportional to the velocity of the conductor • The conductive blood is the moving conductor. • A permanent magnet or electromagnet positioned around the blood vessel generates a magnetic field perpendicular to the direction of the flow of the blood, • Voltage induced in the moving blood column is measured with stationary electrodes located on opposite sides of the blood vessel and perpendicular to the direction of the magnetic field. • This method requires that the blood vessel be exposed so that the flow head or the measuring probe can be put across it.	**2M**
	OR In the block diagram given below, the oscillator which drives the magnet and provides control signal for the gate, operates at a frequency of between 60 and 100 Hz. Voltage induced in the moving blood column is measured with stationary electrodes located on opposite sides of the blood vessel and perpendicular to the direction of the magnetic field. The use of a gated detector makes the polarity of the output signal reverse when the flow direction reverses. The	

		frequency response of the system is high to allow the recording of flow pulses. Average flow is obtained by using low pass filter.  	
d)	**Draw the diagram of CAT machine and state the function of any two components**		**4 M**
Ans.	**Diagram:**  **OR**		**2M**



Working of CAT scanner :

The CT scanner consists of gantry, patient table. X ray tube, detector assembly, computer and monitor. X ray tube and detector assembly mounted opposite each other in a rigid gantry rotates once around the patient.

X ray system belongs to the rotating part of gantry
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 processes this data and produces images of the measured values.
The image system controls the function of CT scan such as reconstruction, display and evaluates 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.

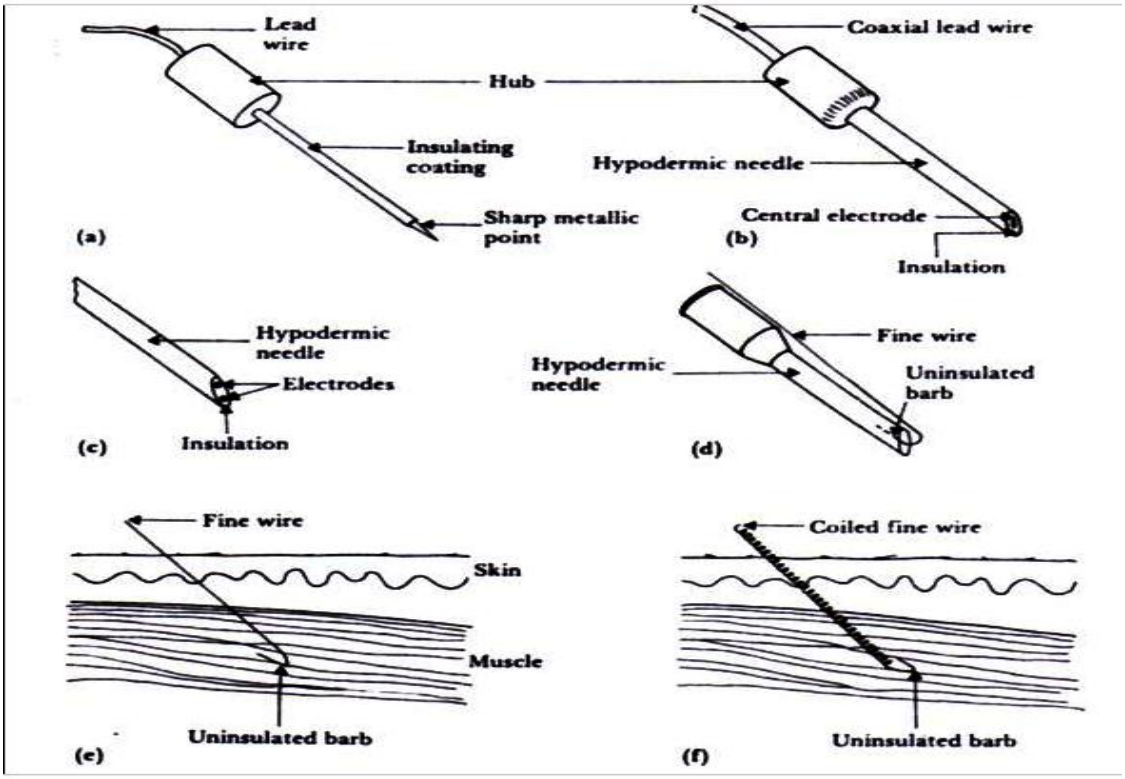
The data measurement system belongs to the rotating part of the gantry and contains all the elements to measure the attenuated radiation and to transfer this to image system for reconstruction and display of CT image.

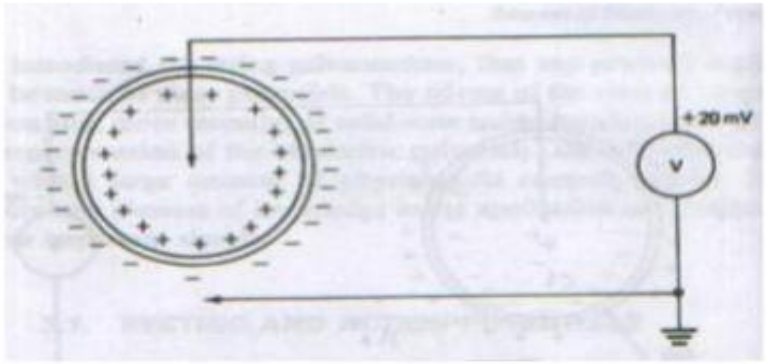
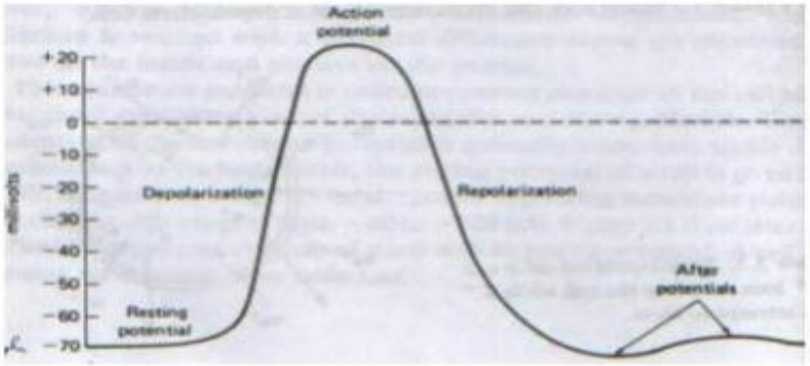
.

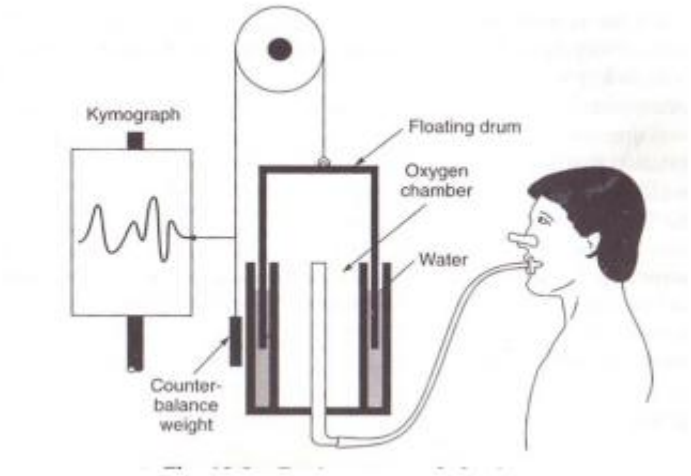
The scanning system contains the function of gantry rotation, gantry tilt, to exchange data with X ray system and data measurement.

The patient handling system consists of patient table, motor for vertical and horizontal drive and system controller.

2M for functions of any two blocks

		The power distribution system provides power supply to all the various systems shown in the block diagram.	
	e)	**Draw and describe the function of needle electrode.**	**4 M**
		Diagram:  **Description:** • To reduce the interface and noise (artifact) caused due to electrode movement, during the measurement of EEG, EMG etc., small sub dermal needles are used. • In EEG measurements these electrodes are inserted through a small section of the skin just beneath the surface and parallel to it. They are not inserted into the brain. The needle electrodes for EMG measurement consist of fine insulated wires placed in such a way that their tips which are bare are in contact with the muscle, nerve or other tissues from which the measurement is to be made. • The main advantage of needle electrodes is that they are less susceptible to movement artifacts than surface electrodes. • Also the needle electrodes have lower impedances when compared to surface electrodes as it makes direct contact with the sub-dermal tissues or intracellular fluid.	**2M** **2M**
Q. 4	**a)**	**Attempt any THREE of the following**	**12 M**
	i)	**Describe action potential with the help of neat and labeled diagram**	**4 M**
	Ans.	**Action potential:** When an excitable cell in the body which is at rest and having resting potential, is excited by any external excitation or stimulus then the property of cell membrane changes.It allows entry of Na+ ions. The large number of Na+ ions tries to enter inside the cell .At the same time K+ ions try to leave the cell but are unable to move as fast as Na+ ions. So after some time, potential inside the cell body is more +ve than outside. This developed potential in the cell is called "action potential "and is approximately around +20mV. The process of changing of a	**2M**

		cell from resting state to the action potential is called depolarization **Waveform:**  **Typical waveform**  	**2M**
	ii)	**List various effects of leakage current that occur with the increasing current density on human body.**	**4 M**
	Ans.	The effects of leakage current that occur with the increasing current density on human body is as below: • Threshold of perception: It is at approximately 500 micro A or 1 mA. • Accepted safe level: It is up to 5 mA. It is not considered harmful though the sensation may be painful. • Maximum let go current: The maximum current level a person can tolerate and still voluntarily let go of the conductor is called "let go" current level. It is around 10mA to 20mA. It can tetanize the arm muscle. • Danger of ventricular fibrillation: This can occur for currents above 75 mA. • Contraction of heart (Sustained myocardial contraction): This happens when current is in excess of about 1A or 2A. This may be accompanied by respiratory paralysis. • Severe burns and physical injury: It occurs when current is above 10A. • Danger of respiratory paralysis: It is caused when current is more than 100mA.	**4M for any four effects**
	iii)	**Describe working of spirometer to measure respiration rate with neat and labeled diagram**	**4 M**
	Ans.	**Diagram:**	**2M**



2M

Working of Spirometer :

- Spirometer is a device which is used to determine all lung volumes and capacities.
- The above figure represents a Spirometer.

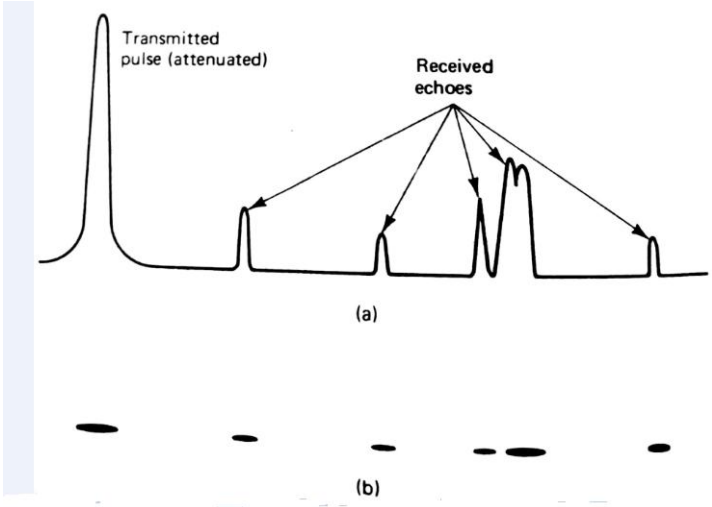
- The standard spirometer consists of a movable bell inverted over a chamber of water. Inside the bell, above the water line is the gas that is to be breathed.
- The bell is counterbalanced by a weight to maintain the gas inside at atmospheric pressure so that its height above the water is proportional to the amount of gas in the bell.
- A breathing tube connects the mouth of the patient with the gas under the bell.
- As the patient breathes into the tube, the bell moves up and down with each inspiration and expiration in proportion to the amount of air breathed in or out.
- The motion is recorded on an adjacent drum recorder called the Kymograph through a pen that is attached to a counter balancing mechanism.

iv) Describe A and B mode of ultrasonography with the help of waveform.

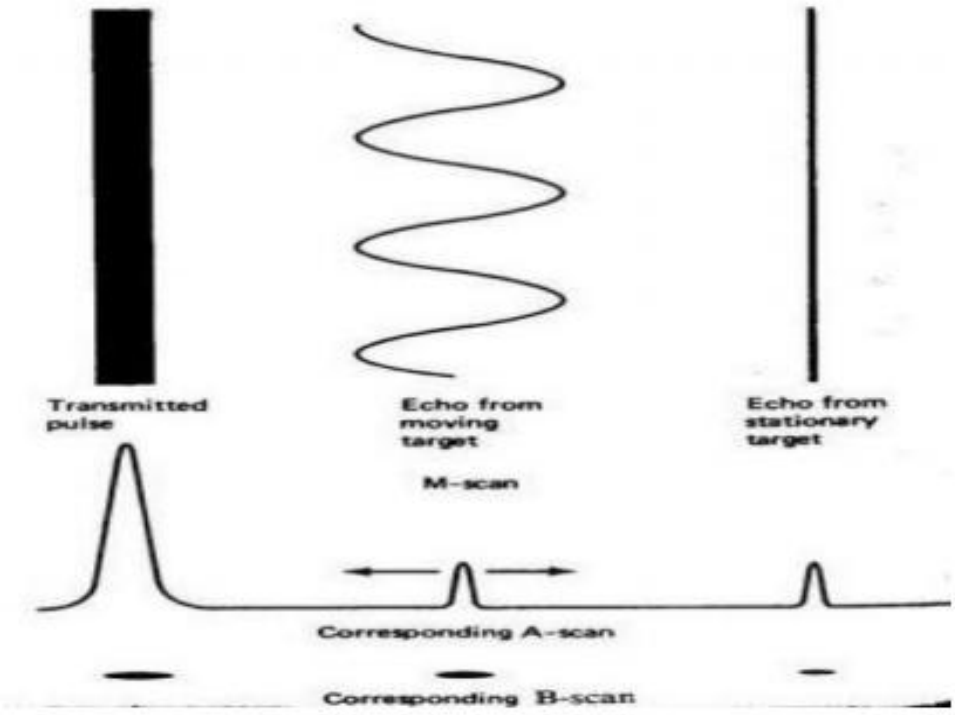
2M

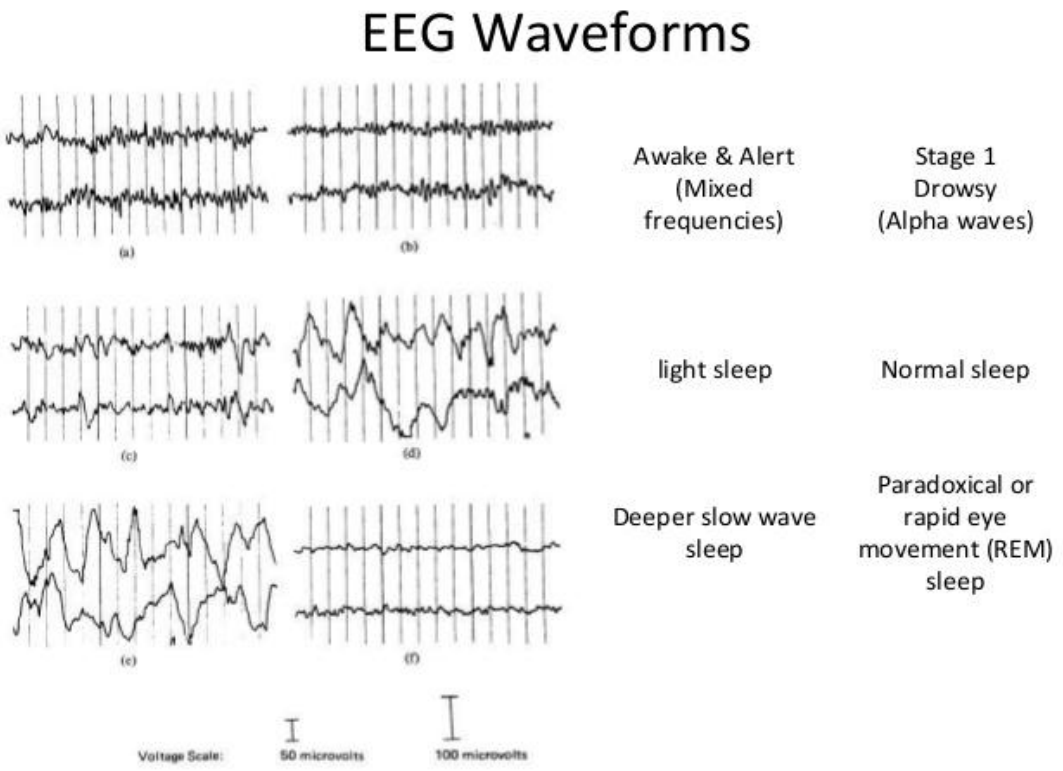
Ans.

Waveform s of A scan and B scan modes



(a) = A-Scan
(b) =B scan of the same target

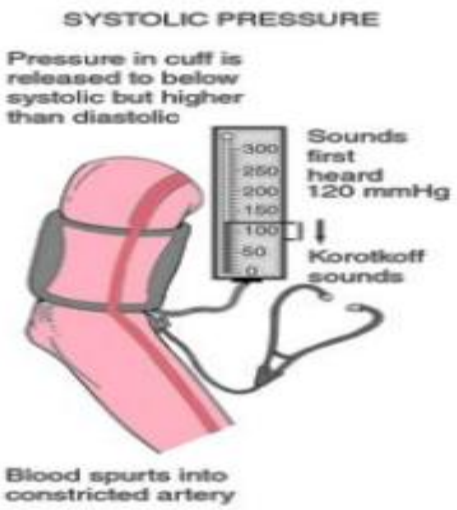
		OR  **A scan:** This mode is the simplest among other methods. The transmitted signals and echo signals are applied to the Y plates of CRT so that they are displayed as vertical deflections on the CRT screen. The vertical sweep is calibrated in units of distance and provides vertical deflections in various ranges depending upon the distance of the interface. Echoencephalogram is typical example of A scan display. **B scan:** If A scan echoes are rotated electronically 90° towards the viewer, the echoes can be viewed along the horizontal axis as bright and dim dots. The distance between the bright and dim dots represents the depth of tissues and the brightness of the dots represents the strength of the echoes. These dots can be used to obtain a pictorial display of internal organs if position of the probe is continuously moved and the corresponding echoes are obtained.	**1.5M** **1.5M**
	b)	**Attempt any ONE of the following**	**6**
	i)	**Draw the different waveform of EEG. At the various stages of sleep.**	**6 M**
	Ans.	**Waveform:**	**1M each**



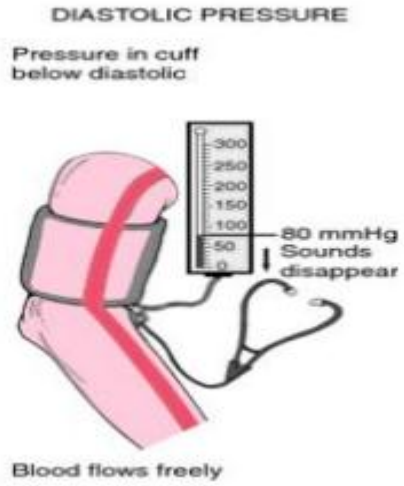
a. Awake and alert condition- mixed frequencies
b. Stage 1- drowsy (alpha waves)
c. Stage 2-light sleep
d. Normal sleep
e. Deep slower wave sleep
f. Paradoxical or rapid eyeball movement (REM) sleep.

	ii)	**Describe the working of sphygmomanometer with the help of diagram.**	**6 M**
	Ans.	**Diagram:** **Step 1:**  	**2M**

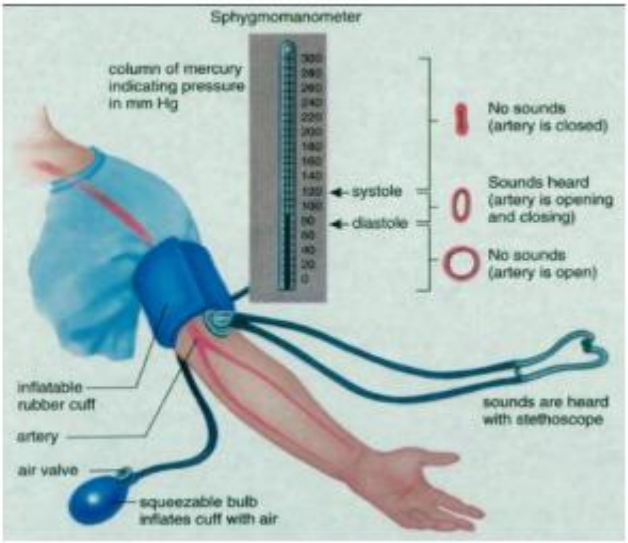
Step 2:



Step 3:

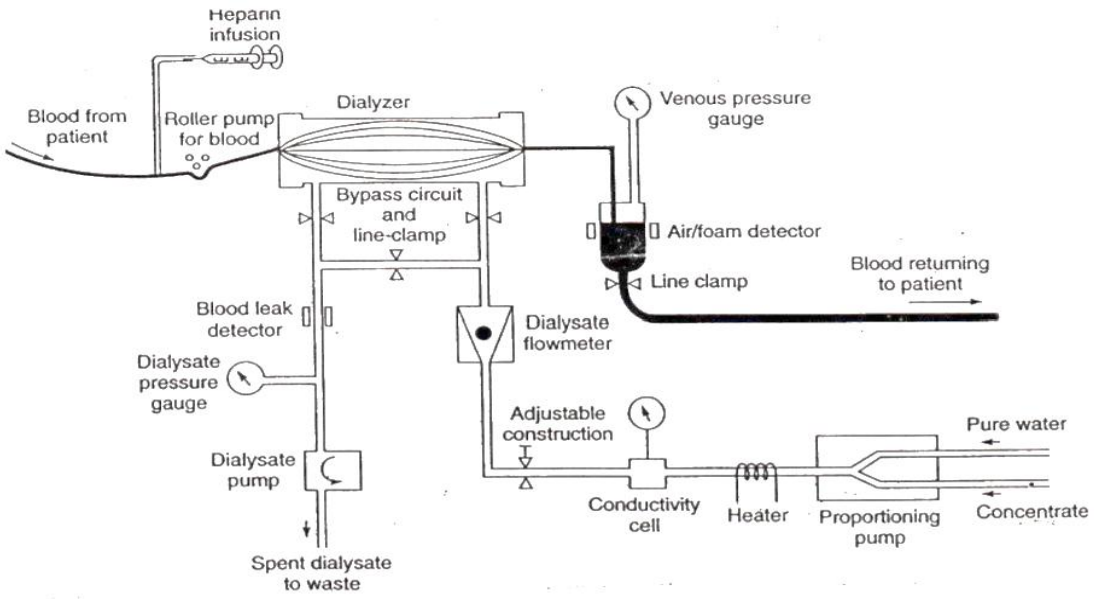


OR



Description :

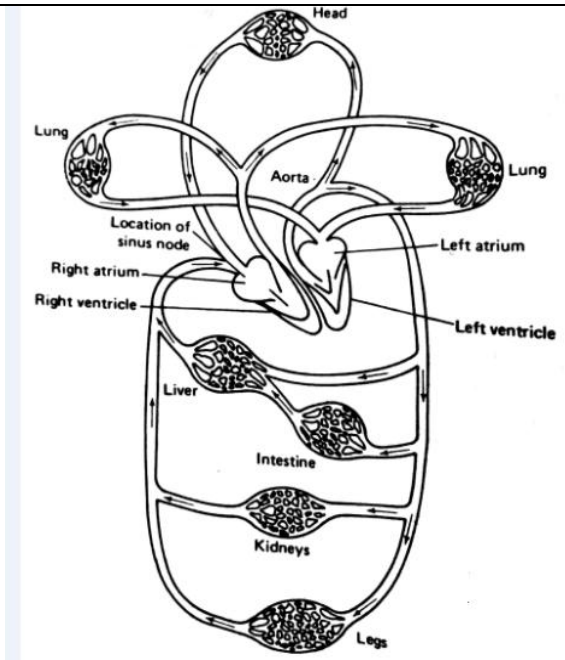
		• The indirect method of measuring blood pressure involves use of Sphygmomanometer and a stethoscope. Sphygmomanometer consists of an inflatable pressure cuff and mercury manometer to measure the pressure in the cuff. • The cuff consists of a rubber bladder inside an inelastic fabric covering that can 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 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 as the artery is temporarily occluded by the pressure of the cuff. • The pressure in the artery is gradually reduced by opening needle valve 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 indicated in the manometer when the first Korotkoff sound is heard is called systolic blood pressure. • As the pressure continues to drop, Korotkoff sounds will continue till the cuff pressure is no longer sufficient to occlude the vessel. The pressure at which Korotkoff sounds disappear is recorded as Diastolic pressure.	**4M**
Q. 5		**Attempt any TWO of the following**	**16**
	a)	**Draw the block diagram of dialysis machine. Describe its working in details.**	**8 M**
	Ans.	**Block Diagram of Hemodialysis machine:**	**4 M**



Dialysis machine works as artificial kidney in which treatment takes place and blood is freed from waste products.It has following parts: **4 M**

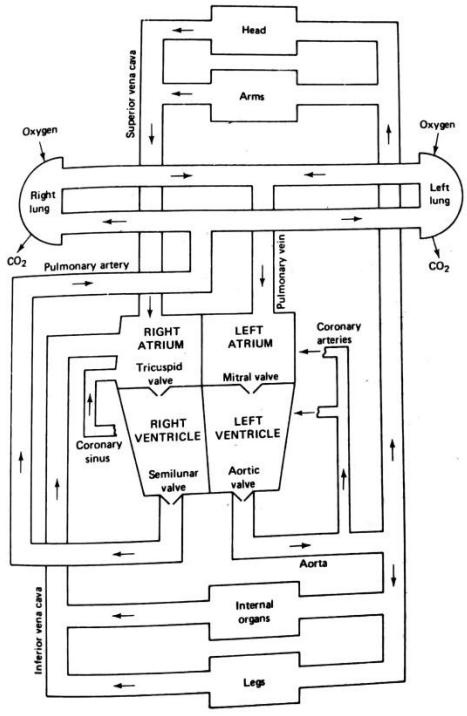
1. Dialyzer- This is the part in which blood filtration actually takes place.
2. Proportionating Pump- It produces steady flow of quality dialysate by having proper proportion of water and concentrated chemical.
3. Dialysate temp control – It is used to maintain the temperature of the dialysate at body temperature.
4. Conductivity measurement unit: It is used to monitor the conductivity of the dialysate produced. If there is more deviation, the dialysate is bypassed to the drain
5. Heparin infusion- It is done in order to avoid coagulation or clotting of blood, which is taken from the patient.
6. Venous pressure gauge - It monitors the pressure of blood which is given back to the patients.
7. Air/Foam Detector- It detects the presence of air / Foam in the blood to avoid danger.
8. Blood leak detector - It detects the leakage of blood from the dialyzer
9. Bypass circuit and line in clamp-: It is used to bypass the dialysate flow, for replacement, maintenance or repair of dialyzer.
10. Ultra filtration monitor unit: This is used to monitor the amount of fluid removed from the patient and control the rate at which it is removed.

	b)	**Describe cardiovascular system with neat and labeled diagram**	**8 M**
	Ans.	**Diagram of cardiovascular system**	



4 M for any one diagram

OR



Description:

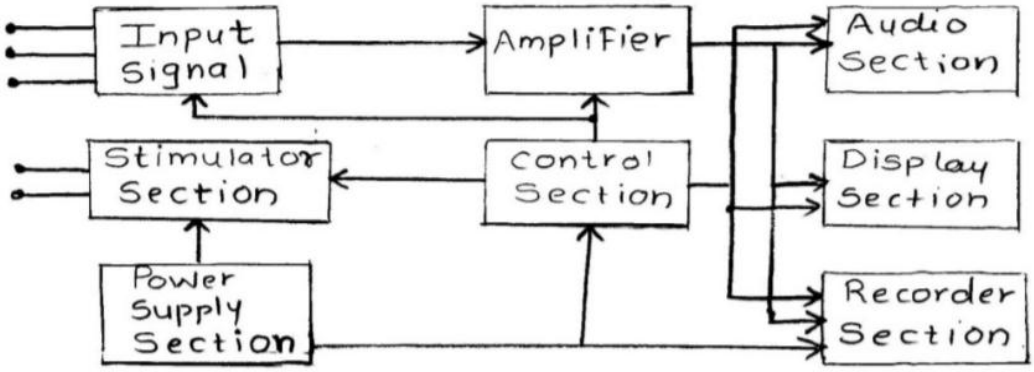
The cardiovascular system is a complex closed hydraulic system which performs the essential service of transportation of oxygen ,carbon dioxide, several chemical compounds and blood cells.

Blood is carried to various parts of the body through blood vessels. There are three types of blood vessels.

i) Arteries which are thick walled and carry oxygenated blood away from the heart.

4M

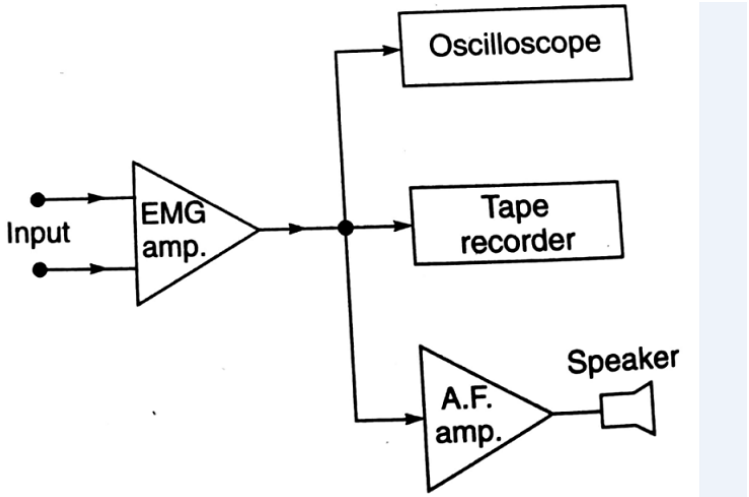
		ii) Veins which are thin walled and carry deoxygenated blood towards the heart. iii) Capillaries which are the smallest and last level of blood vessels . The heart drives blood through the blood vessels of the circulatory system. It can be considered as a two stage pump. It is divided into four chambers – Right atrium Right Ventricle Left Atrium Left Ventricle 1. The superior and inferior venacavae are connected to right atrium. 2. These venacavae bring deoxygenated blood from different body parts to the right atrium. 3. Then deoxygenated blood goes to the right ventricle through Tricuspid valve. 4. Deoxygenated blood from the right ventricle goes to the lungs through pulmonary artery. 5. Lungs oxygenate the blood and send it to the left atrium through pulmonary veins. 6. Then oxygenated blood comes to left ventricle through bicuspid valve. From there it gets distributed to different parts of the body through aorta.	
	c)	**Draw the neat diagram of EMG. State the functions of each component.**	**8 M**
	Ans.	1. Power Supply Section: It produces a number of regulated voltages, which are used to supply analog and digital sections of the system 2. Stimulator Section: It receives control signal from control section. The control section generates trigger pulses at definite intervals to initiate operation of nerve and muscle stimulator and controls stimulus repetition rate. 3. Input Section: The input section of the EMG equipment consists of electrode junction box, calibration network and pre-amplifier. The EMG signals received from the patient are fed to the pre amplifier in electrode junction box. It is a buffer amplifier which has high input impedance, low noise and low output impedance. A calibration network applies a rectangular voltage 100mV to the input of amplifier section when a calibration button is pressed to test the recorder and generate reference waveform. 4. Amplifier Section It amplifies the signal to a desired level. A multiple steps filter employed here allows only a signal of selected bandwidth to pass to next circuit i.e ADC in control section. 5. Control Section It consists of central processing unit, keyboard memory, interfacing unit etc. After processing the signal in control section, it is again converted to analog converter and fed to CRT. 6. Display section: Normally CRT type displays are used with EMG machine. The display has two modes: Continuous and triggered. The control section also generates two cursors on the CRT screen to perform measurements on the waveform. 7. Recorder Section: A power galvanometer with hot stylus is used as a recorder in EMG. In EMG system a low frequency signal is generated using a processor to suit frequency response of galvanometer and recorded. 8. Audio Section: Being the EMG signals are in audible frequency range, an audio amplifier and speaker are incorporated in EMG machines. Audio amplifiers of 2 to 7 watts are very commonly used in EMG machines. EMG machine.	**4 M**



EMG machine

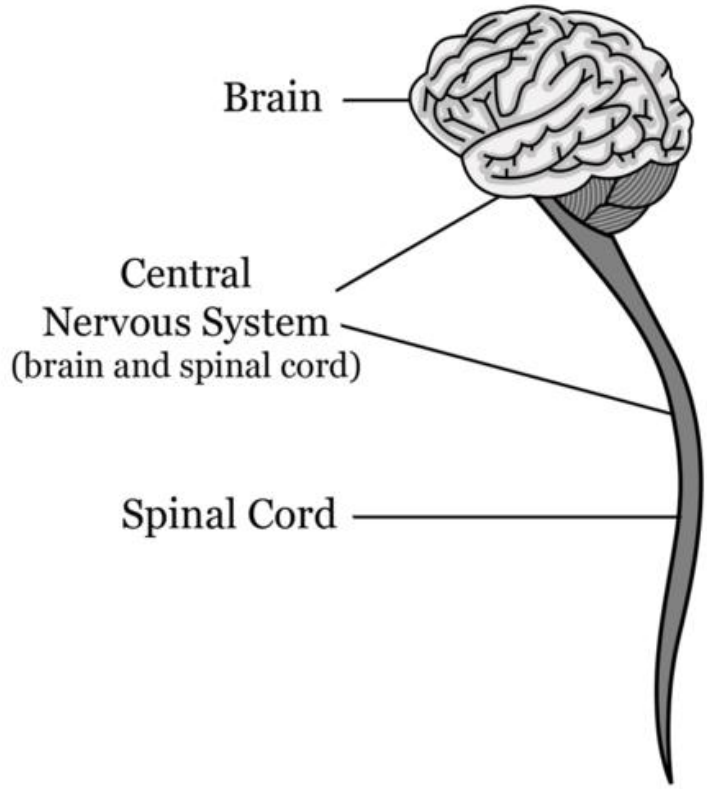
4 M

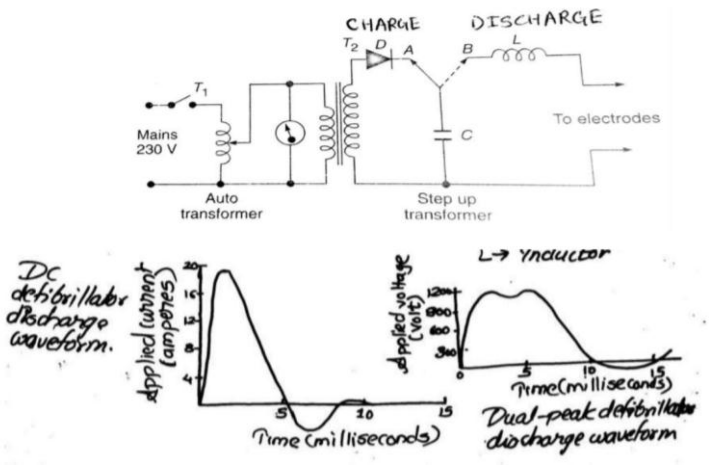
(OR)

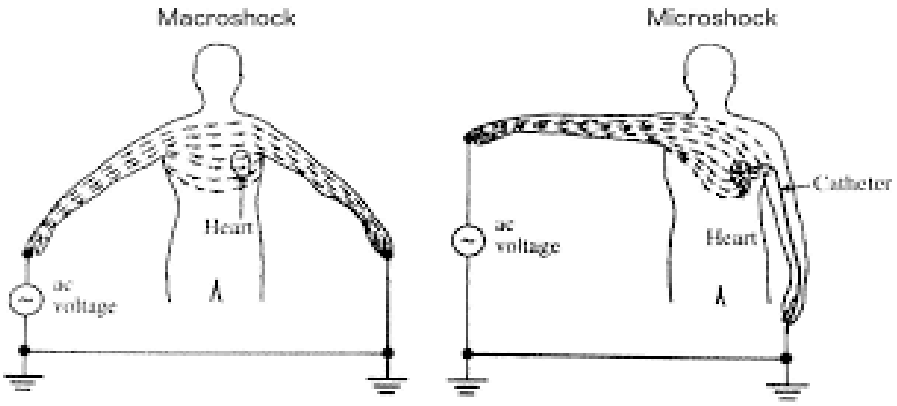
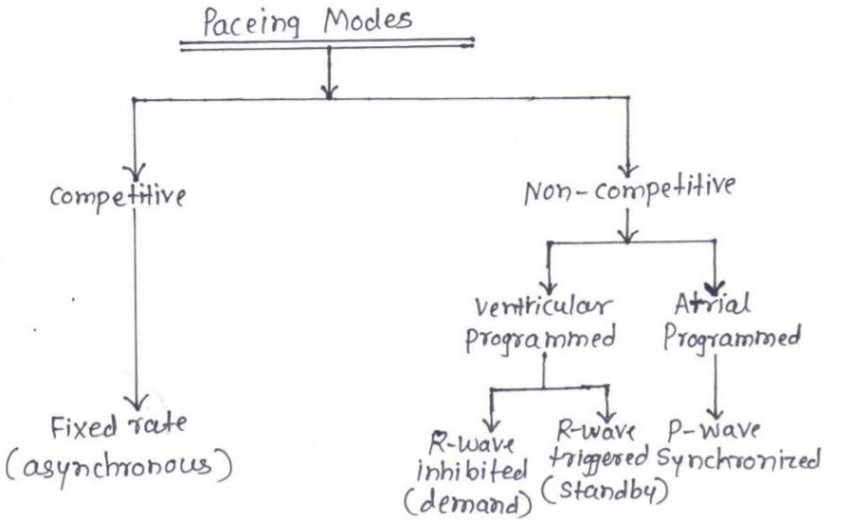


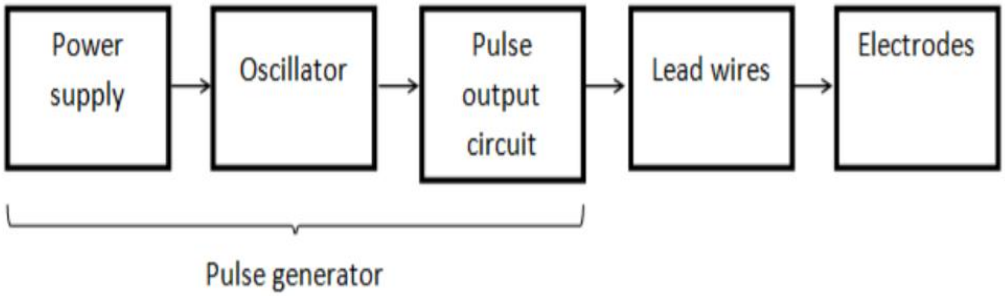
Electromyograph is an instrument used for recording the electrical activity of the muscles.It is recorded using surface or needle electrodes. A ground electrode is used for common reference for measurement.
Figure above represents the block diagram of an electromyograph .
These electrodes pick up the potentials produced by the muscle fibres. The signal is then amplified and displayed on the screen of a cathode ray tube. The oscilloscope displays the EMG waveforms. These waveforms can be photographed from a synchronized camera.
The tape recorder present records the waveforms which can be studied at a later time.
The signal is also applied to an audio amplifier connected to a loud speaker. A trained EMG interpreter can diagnose the muscular disorders by listening to the sounds produced when the muscle potentials are fed to the loud speaker.

Q. 6		**Attempt any FOUR of the following**	**16 M**
	a)	**State the function of cerebrum and medulla oblongata**	**4 M**
	Ans.	**Functions of Cerebrum:** The cerebrum or cortex is the largest part of the human brain, associated with higher brain	**2 M Any**

		function such as thought and action. 1) It controls all voluntary activities. 2) It is the center for emotions, thoughts, and feelings like pain, pleasure, fear, etc. 3) It is the center of memory, will power, intelligence reasoning and learning. 4) It perceives sensory stimuli through vision, taste, smell, sound ,touch and speech. **Functions of Medulla Oblongata:** It controls all the involuntary functions of the body. 1) It control blood pressure 2) Regulates breathing or respiration, heart and blood vessel function 3) reflex center of vomiting, coughing, sneezing ,swallowing,etc. 4)Regulates kidney functions	**two** **2 M** **Any two**
	b)	**Describe the working of nervous system in human body with neat diagram.**	**4 M**
	Ans.	**The nervous system is divided into two parts:** **1. Central Nervous System** **2. Peripheral Nervous System** The Central nervous system consists of Brain and Spinal Cord.  The brain is the most complex organ in the human body. It consists of Cerebrum, Cerebellum, Midbrain, brain stem, Medulla It is also divided into several lobes: • The frontal lobes are responsible for problem solving and judgment and motor function. • The parietal lobes manage sensation, handwriting, and body position.	**2 M** **2 M**

		• The temporal lobes are involved with memory and hearing. • The occipital lobes contain the brain's visual processing system. At the lower end, the brain connects with the spinal cord. The spinal cord controls many reflex actions like knee reflex. The peripheral nervous system comprises of all nerves and group of neurons outside brain and the spinal cord. These neurons have the ability to transmit electrical signals called nerve impulses.	
	c)	**Explain DC defibrillator with neat circuit diagram.**	**4 M**
	Ans.	 **DC Defibrillator circuit and discharge waveforms** 1. It consists of a variable auto transformerT_1 connected to the primary winding of a step -up transformer T_2. 2. The output of the transformer is rectified by a diode rectifier. 3. It is connected to a vacuum type, high voltage changeover switch. When it is at position A ,it is connected to one end of an oil filled 16 microfarad capacitor. In this position, the capacitor is charged to a voltage set by the position of autotransformer. 4. When shock is to be delivered to the patient, the position of the switch is changed to B. 5. The capacitor is discharged across the heart through the paddle electrodes. 6. An inductor in the defibrillator is used to shape the waveform in order to avoid sharp current spike. 7. Depending on the energy setting the amount of electrical energy discharged by the capacitor may of the range 100W and 400 W per second.	**2 M** **2 M**
	d)	**Describe micro shock and macro shock with patient safety.**	**4 M**
	Ans.	**Micro-shock:** When an interaction of electric current takes place with human body or human body tissues in such a [Tricuspid Valve] act is applied directly to the heart & other to body surface, the effect of cu heart is often referred to as micro- shock. **OR** The effect of electric current on human body when both conductors or at least one conductor is directly applied to the heart is called micro-shock. **Macro shock**: When an interaction of electric current takes place with human body or human	**2 M** **2 M**

		body tissues in such a way that current is applied through the surface contacts, the effect of current is called macro shock. **Or** The effect of electric current on human body when both contacts are applied through the surface of the body is called macro-shock. 	
	e)	**Classify pacemaker. Describe any one in brief with diagram.**	**4 M**
	Ans.	Types of Pacemaker – 1. Internal Pacemaker 2. External Pacemaker. Classification of pacemaker based on pacing modes:  **External Pacemaker:**	**2M**



1 M

1. External pacemaker is used to start the normal rhythm of the heart in case of cardiac failure.
2. Metal electrodes are placed on the surface of the body after applying jelly for proper contact and for preventing burning of the skin.
3. 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.
4. 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.
5. On demand hysteresis pacing – this pacemaker starts pacing at 7 ppm automatically whenever the heart rate goes below 60.
6. All external pacemaker require 150 V (max.) amplitude across an impedance of 1 KΩ.
7. Each pulse applied by the external pacemaker causes an uncomfortable contraction of thoracic muscle around the area of the electrode as well as burning of the skin.
8. Hence external pacemakers are used only temporary heart blocks either during or after surgery, or for short term treatment of arrhythmia.

1 M

OR

Marks may be given to other type of pacemaker like internal pacemaker.