SUMMER – 2019 EXAMINATION

Subject Name: Diagnostic equipment **Model Answer** **Subject Code:** 22436

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 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.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 M**
	a)	**List any four technical specifications of pulse oximeter** **Ans:** **Technical specifications of pulse oximeter:** Power: 230V AC,50Hz or Battery 4.5V Spo2 Range:0-100% Spo2 Accuracy:+-2digits at 70 to 100% Pulse rate range : 30 to 300bpm Pulse rate accuracy :+- 3%, +-1 digit Sensor : Optoelectric (650nm and 805nm)	**02 M**
	b)	**State the concept of foetal heart rate** **Ans:** **Concept of foetal heart rate:** A normal fetal heart rate (FHR) usually ranges from 120 to 160 beats per minute (bpm) in the inutero period. It is measurable sonographically from around 6 weeks and the normal range varies during gestation, increasing to around 170 bpm at 10 weeks and decreasing from then to around 130 bpm at term. A slow fetal heart rate is termed a fetal bradycardia and is usually defined as FHR <100 bpm before 6.3 weeks gestation, or FHR <120 bpm between 6.3 and 7.0 weeks A rapid fetal heart rate is termed a fetal tachycardia and is usually defined as: FHR >160-180 bpm FHR around 170 bpm may be classified as borderline fetal tachycardia A rapid and irregular fetal heart rate is usually termed a fetal tachyarrhythmia.	**02 M**
	c)	**Draw block diagram of ECG machine** **Ans:**	

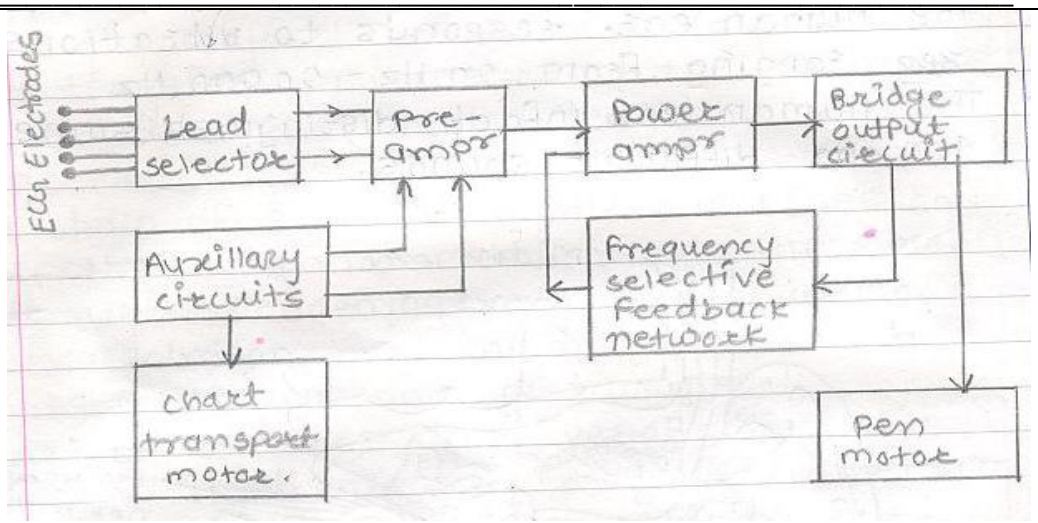


Fig: ECG machine — **02 M**

d) State the lambert law. — **02 M**

Ans:

Lambert law:

A light absorbing medium of concentration C and thickness b, the intensity of transmitted light l is related to the incident light Io as follows:

I = Io –kCb where k is known as extinction coefficient and varies as function of the substance and the wavelength of light. The quantity KCb is called the absorbance A.

e) Mention any two possible faults which can occur in EEG machine and write remedies for it.

Ans:

Symptoms	Remedies
Machine runs, but the tracing on one or more channels is missing	1. Check ink reservoirs. 2. Check ink tubes for clogging. 3. Check for upwardly bent pens-gently push pen onto paper with finger or pencil to observe any touching
Spotty recordings (Light or dark).	1. Check paper loading. 2. And if proper, then check pen for Worn tip (ink not feeding properly)

Table: Possible faults which can occur in EEG machine and write remedies — **01 M** **01 M**

f) State the concept of Galvanic skin reflex. — **02 M**

Ans:

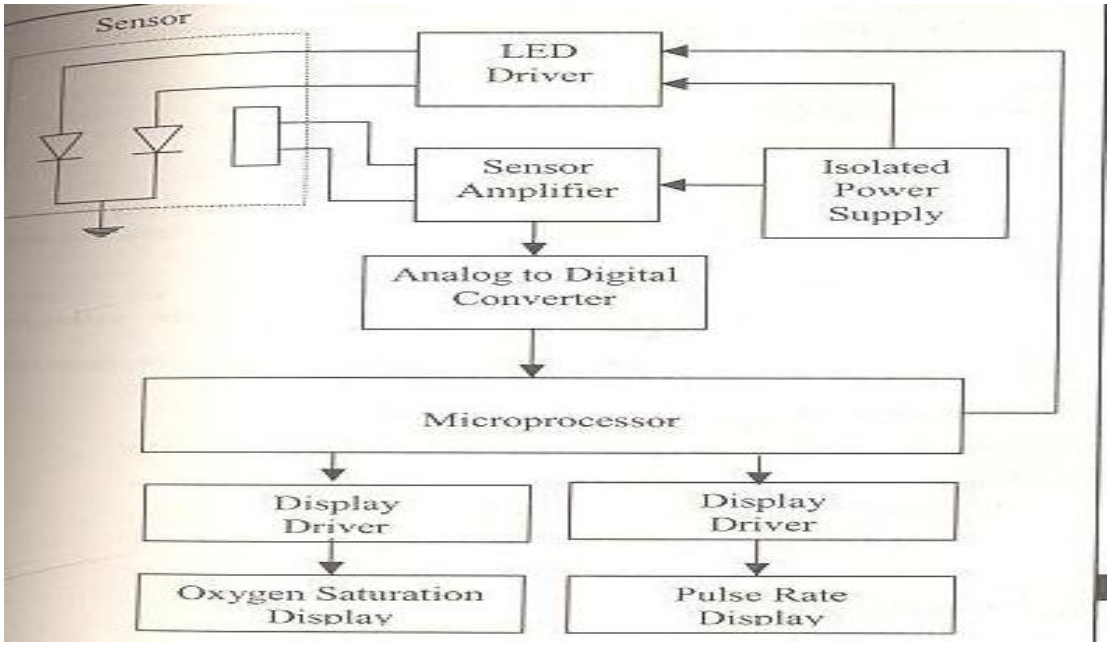
Galvanic skin response (GSR):

A change in the electrical properties of the body (probably of the skin) following noxious stimulation, stimulation that produces emotional reaction, and, to some extent, stimulation that attracts the subject's attention and leads to an aroused alertness. The response appears as an increase in the electrical conductance of the skin (a decrease in resistance) across the palms of the hands or soles of the feet. It appears about two seconds after stimulation, as by a pinprick or threat of injury; it rises to a maximum after two to ten seconds and subsides at about the same rate.

g) Explain 'beat to beat and average' method for calculation of heart rate. — **01 M**

Ans:

1. **Beat-to-beat calculation:** This is done by measuring the time(T), in seconds, between two consecutive pulses, and converting this time into beats /min=60/T. This

		technique accurately represents the true picture of the heart rate. **2. Average calculation:** This is the oldest and most popular technique. An average rate (beats/min) is calculated by counting the number of pulse in a given time. The average method of calculation does not show changes in the beats and thus does not represent the true picture of the heart's response to exercise, stress and environment**.**	**01 M**
2.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Draw block diagram of pulseoximeter and explain it.** **Ans:**  **Pulse Oximeter** • The sensor of pulse oximeter consists of red and infra red light sources and detector. • The LED driver provides drive to red and infrared LED's. The red and infrared LED's are illuminated separately so that photo sensor output represents a signal firstly from one LED and then from the other. • This allows signal processor circuitry to determine transmission of intensity of each wave length without interference from the LED. • The sensor amplified provides necessary amplification to this signal. The signal is then converted into digital signal by an analog to digital converter. • The microprocessor circuitry is under software control and determines the system timing and control logic. • The micro processor also provides display outputs to the display drivers for the front panel display of oxygen saturation and pulse rate.	**02 M** **02 M**
	b)	**Write four technical specifications of respiration rate meter** **Ans:** **Technical specifications of respiration rate meter:** 1. Power : 230V AC, 50Hz, or Battery. 2. Measuring range : 0 to 50 Breaths. 3. Transducer : Nose (Thermistor) or chest (strain gage). 4. Display : 7 segment LED or LCD. 5. Respiration indication: Audio beep and LED	**04 M**
	c)	**Differentiate between ECG and PCG (any four).** **Ans:**	

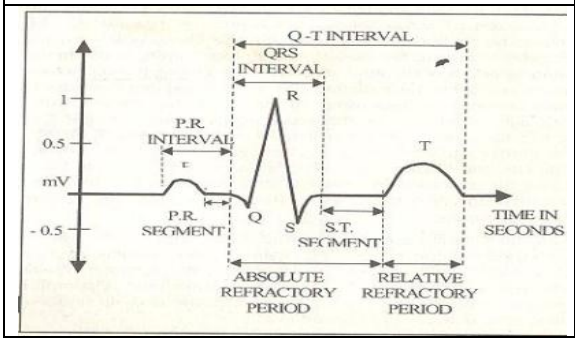
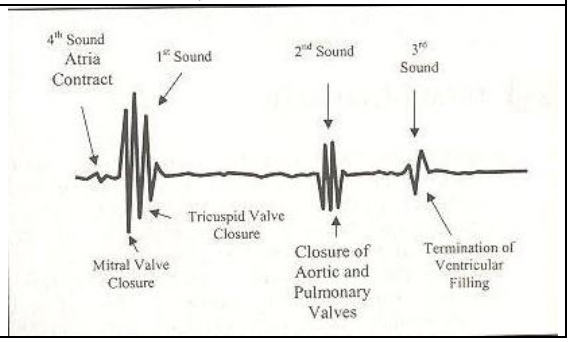
ECG Electrocardiogram	PCG Phonocardiogram
It is the recording of electrical activity of heart functioning	It is the recording of the sounds connected with the pumping action of heart.
It is rhythmically repeating signal synchronized by heart function	These sounds provide an indication of heart rate and its rhythm city.
The origin of ECG signal is SA node in the heart	The origin of PCG signal is pumping action of heart
It provides the recording of electrical activity in the form of PQRS waves.	It provides a recording of wave forms of heart sound.
Its output is in readable form	Its output is in audible form.
To Pick ECG signal surface type of electrodes are used	To Pick PCG signal dynamic microphone or contact sensor microphone can be used as a transducer,
	

Table: Difference between ECG and PCG

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d) Draw block diagram of pure tone audiometer.

Ans:

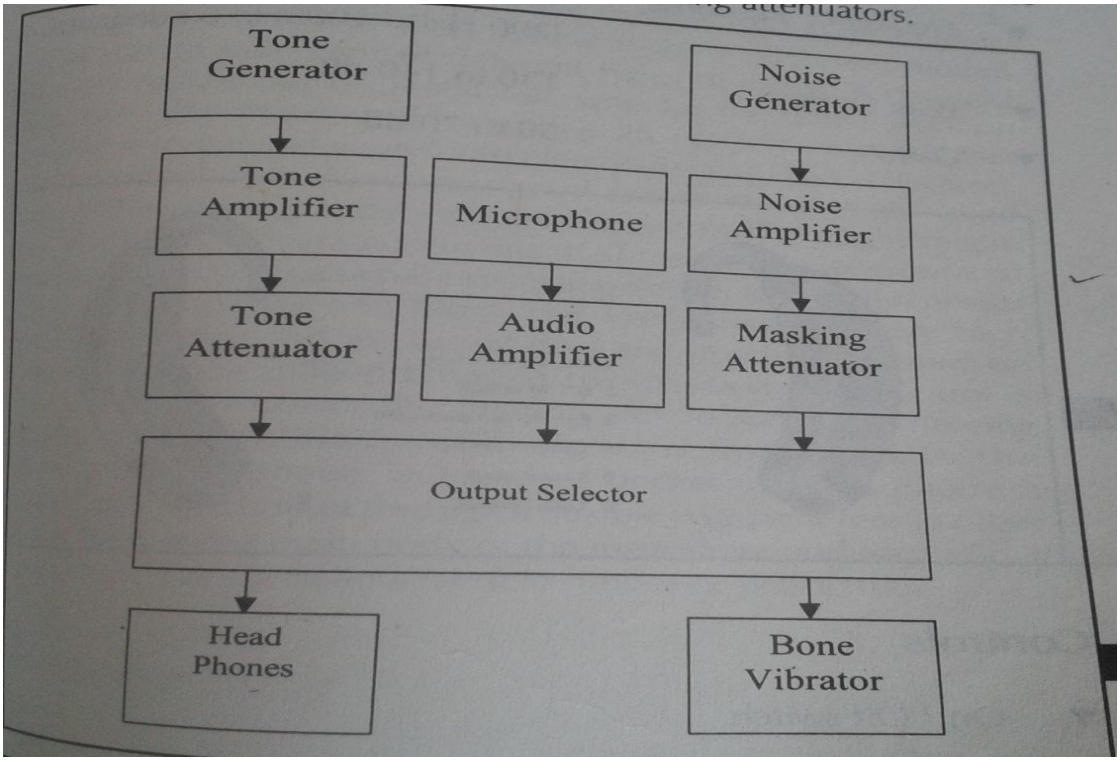
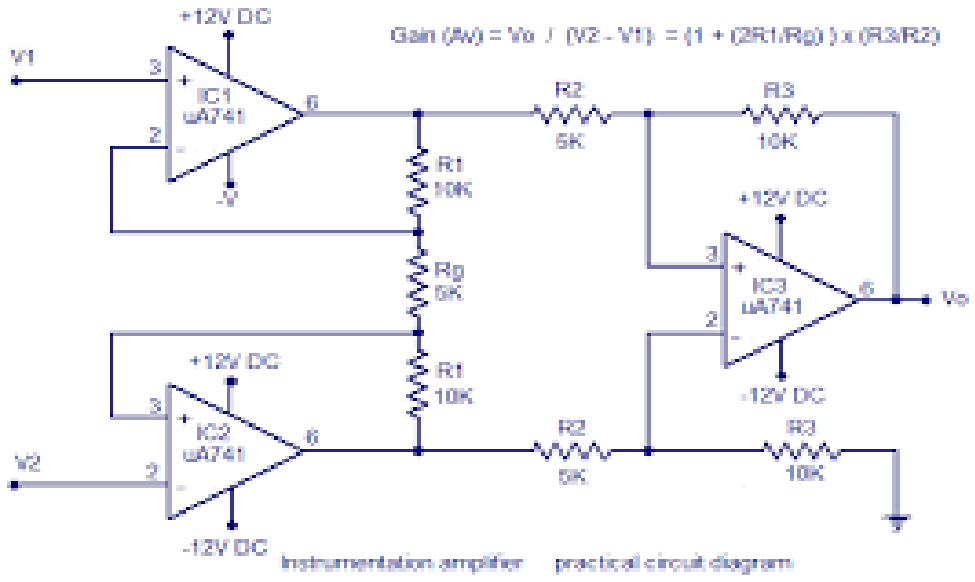
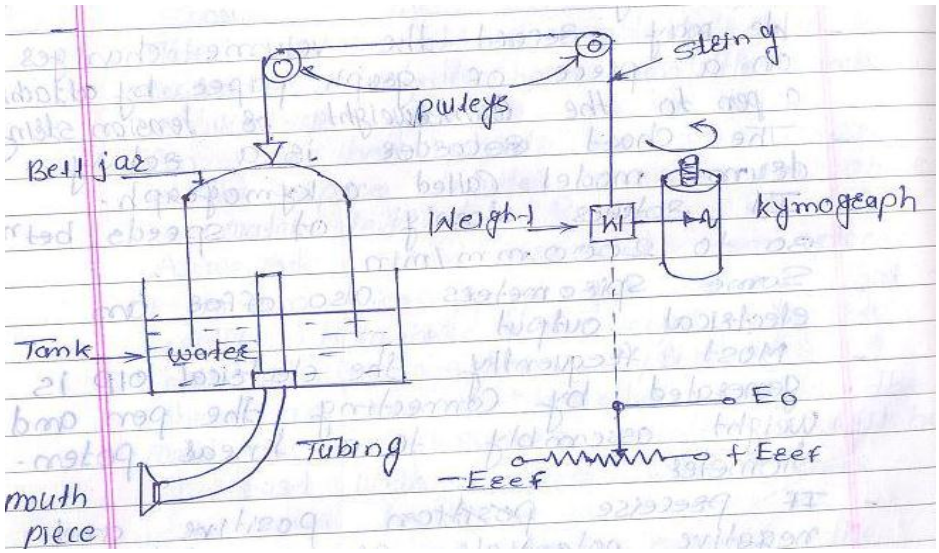
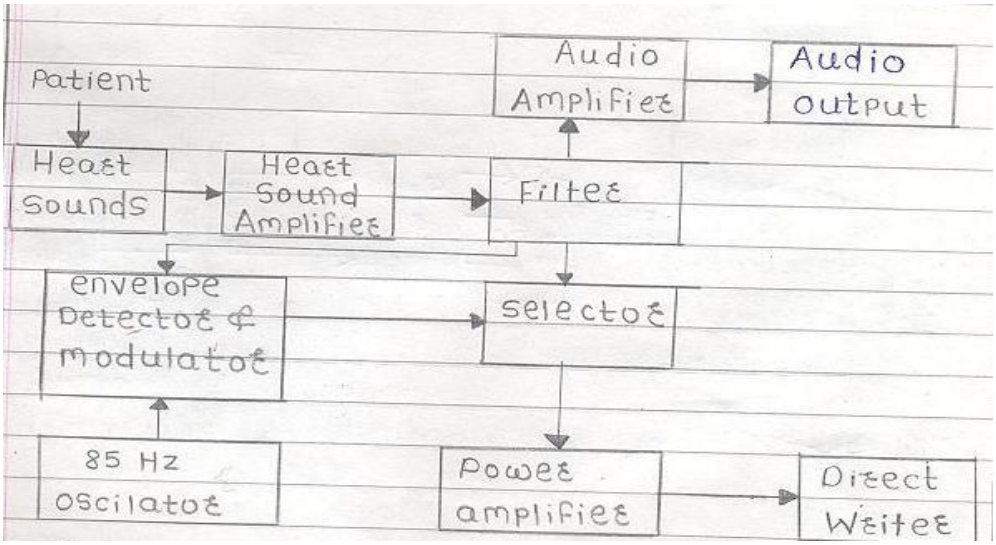


Fig: Pure tone audiometer

04 M

3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Suggest the instrument for measuring the volume of air inspired and expired by the lungs and explain the working principle of it.** **Ans:** **The instrument for measuring the volume of air inspired and expired by the lungs:** The air flow volume in and out of lungs is measured by a device called spirometer and the recording of lung volume changes with time is known as the spirogram. **Working principle of spirometer:** This instrument uses a bell suspended from above in the tank of water. And air hose leads from mouth piece to the space inside of the bell above the water level. Weight is suspended from places a tension force on the string that exactly balances the weight of Bell at atmospheric pressure. When no one is breathing into the mouth piece there for the Bell will be at the rest with fixed volume above the water level. But when the subject exhales the pressure inside the Bell increase above atmospheric pressure. Using the Bell to rise Similarly when patient inhales the pressure inside the bell decreases The Bell will raise when press increases and drop when pressure decreases. The change in Bell pressure changes the volume inside the Bell which also causes the position Of the counter weight to change. We may record the volume change on a piece of graph paper attaching a pen to the counter weight or tension string. The chart Recorder is a rotary drum model called kymograph.	**02 M** **02 M**
	b)	**Draw the preamplifier circuit of ECG machine.** **Ans:**  **Fig: Preamplifier circuit of ECG machine**	**04 M**
	c)	**Describe the generation of EEG signal.** **Ans :** **Generation of EEG signal:** The brain generates rhythmical potentials which originate in the individual Neurons of the brain. These potentials get summated as millions of cell discharge synchronously and appear as a surface waveform the recording of which is known as the Electroencephalogram. The neurons are electrically polarized at rest. The interior of the Neuron is at a potential of about – 70 mV relative to the exterior. When a neuron is exposed to a stimulus above a certain threshold, a nerve impulse is generated which Spreads in the cell resulting in the depolarization of the cell. Shortly afterwards,	**04 m**

		Repolarization occurs. The EEG waveforms have voltage range around 5mv to 100 mv. EEG Signals are mainly classified on the basis of frequency. The normal frequency range of the EEG 0.5 Hz to 30 Hz.	
	d)	**List any four transducers in audiometry.** **Ans:** **Transducers in audiometry:** Generally employed transducers are 1) Earphones 2) Microphones 3) Bone vibrators 4) Loudspeakers	**04 M**
4.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a)	**Draw the standard spirogram and explain any two respiratory parameters.** **Ans:**  **Fig: Spirogram** 1. Tidal volume (TV)- the volume of gas inspired or expired (exchanged with each breath) during normal quite breath is known as Tidal volume. 2. Minute Volume (MV) - the volume of gas exchanged per minute during quite breathing. It's equal to the tidal volume multiplied by the breathing rate. 3. Alveolar Ventilation (AV) - the volume of fresh air entering the alveoli with each breath. Alveolar Ventilation = (Breathing rate) X (Tidal volume – dead space) 4. Inspiratory reserved Volume (IRV) - The volume of gas which can be inspired from the normal end-tidal volume. IRV= VC – (TV + FRC) 5. Expired Reserve Volume (ERV) - the volume of gas remaining after a normal expiration less the volume remaining after a forced expiration. ERV= FRC - RV 6. Residual Volume (RV) - the volume of gas remaining in the lungs after a forced expiration. 7. Functional Residual capacity (FRC) - the volume of gas remaining in the lung after normal expiration. 8. Total Lung Capacity (TLC) - the volume of the gas in the lungs at the point of maximal inspiration. TLC = VC + RV 9. Vital Capacity (VC) - the greatest volume of gas that can be inspired by voluntary effort after maximum expiration, irrespective of time.	**02 M** **02 M**

		10. Inspiratory Capacity (IC) - the maximum volume that can be inspired from the resting end expiratory position. 11.Dead space- Dead space is the functional volume of the lung that does not participate in gas exchange	
	b)	**Draw the block diagram of phonocardiograph and explain it.** **Ans:**  **Fig: Phonocardiograph** The input sound section receive heart sound signal from the microphone placed on patient's heart and feeds the heart sound amplifier. Two types of microphone are used in PCG.Contact or dynamic microphones for phonocardiography and air coupled crystal microphones for pulse wave phonocardiography.A latest contact microphone has frequency response from 20Hz -1KHz.5 Steps filter employed here passes the selector band of heart sounds to power amplifier.Heart sounds & murmurs contain frequencies between 20Hz-2KHz.Standard galvanometer record can record the frequency, which are below 100Hz. But phonocardiograph a direct writing hot stylus galvanometer is used to record heart sound & murmurs with special electronic detection method that extracts the shape, timing duration, amplitude of heart sound over entire 20Hz-2KHz spectrum.Signal's envelope is detected & modulated with 85 Hz frequency, which is generated by 85Hz oscillation.The modulated signals has frequency component of only 85Hz & envelope of acquired heart sound to record the signal using hot stylus galvanometer.At filter positions 25 & 50 being selected band has lower frequency it is recorded directly.On the other hand when filter positions. 100, 250 or 500 are selected signal is modulated & then recorded.	**02 M** **02 M**
	c)	**Describe the 10-20 electrode system with its neat sketch.** **Ans:** The 10-20 System of Electrode Placement is a method used to describe the location of scalp electrodes. These scalp electrodes are used to record the electroencephalogram (EEG) using a machine called an electroencephalograph**.** The EEG is a record of brain activity. The 10-20 system is based on the relationship between the location of an electrode and the underlying area of cerebral cortex. The letters F, T, C, P, and O stand for Frontal, Temporal, Central, Parietal and Occipital. Even numbers (2, 4, 6, 8) refer to the right hemisphere and odd numbers (1, 3, 5, 7) refer to the left hemisphere. The z refers to an electrode placed on the midline. Also note that the smaller the number, the closer the position is to the midline.The "10" and "20" refer to the 10% or 20% interelectrode distance. Nasion - point between the forehead and nose. Inion -	**02 M**

Bump at back of skull.

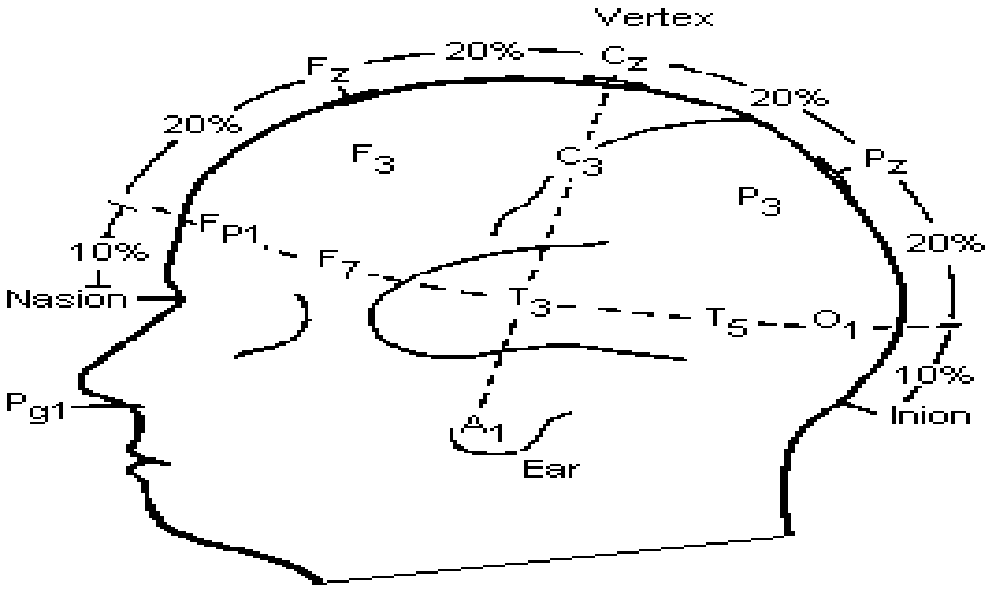


Fig: 10 - 20 Electrode placement system

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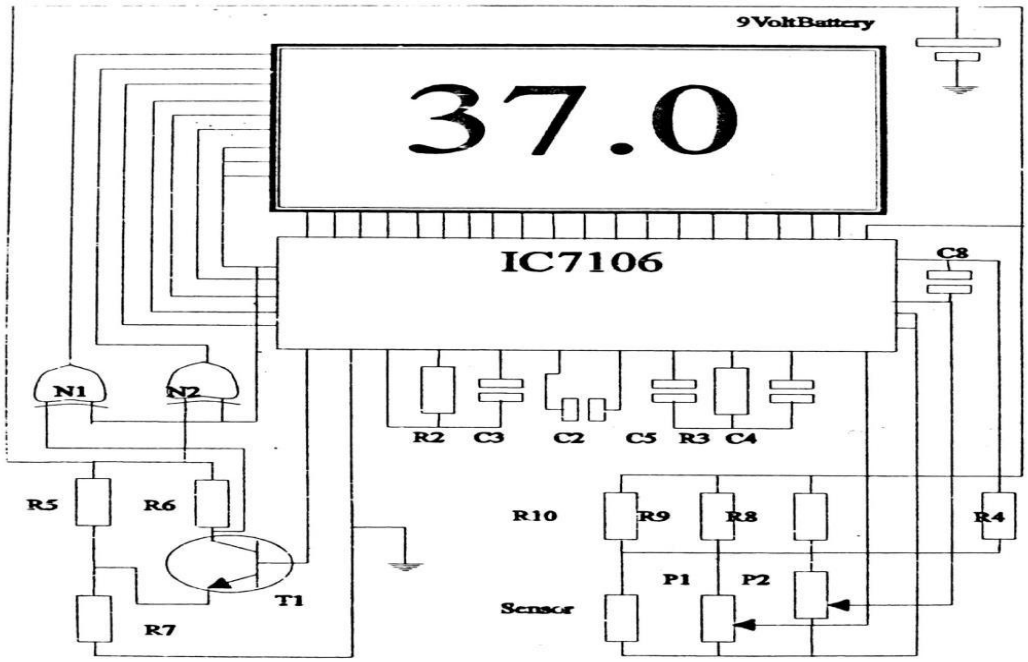
d) State any four possible faults and their solutions for EMG machine.

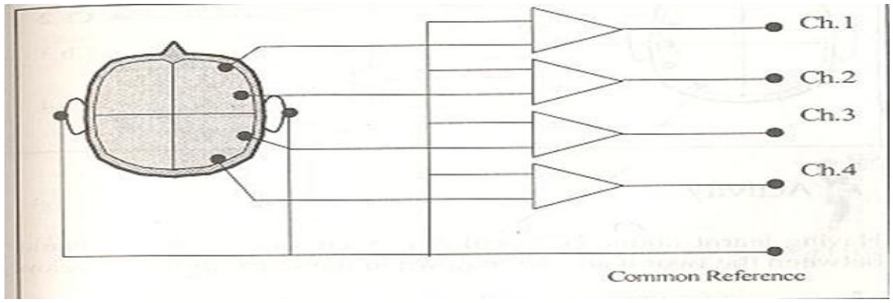
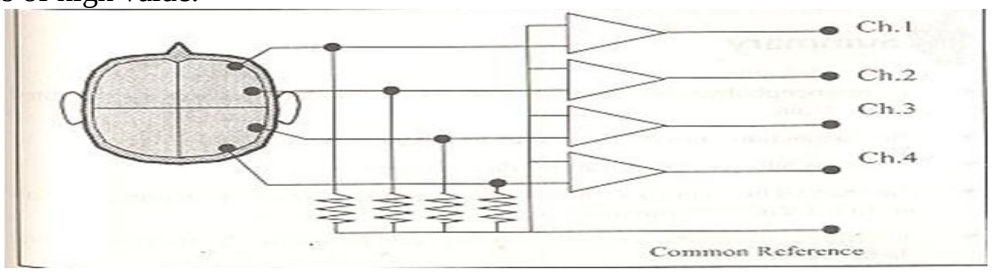
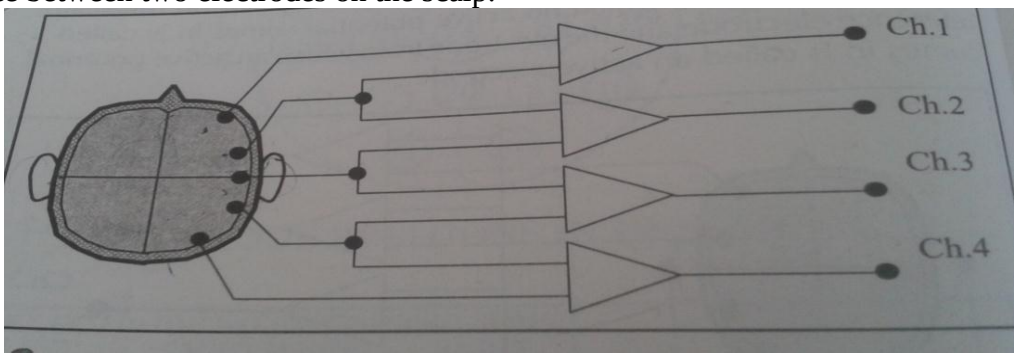
Ans:

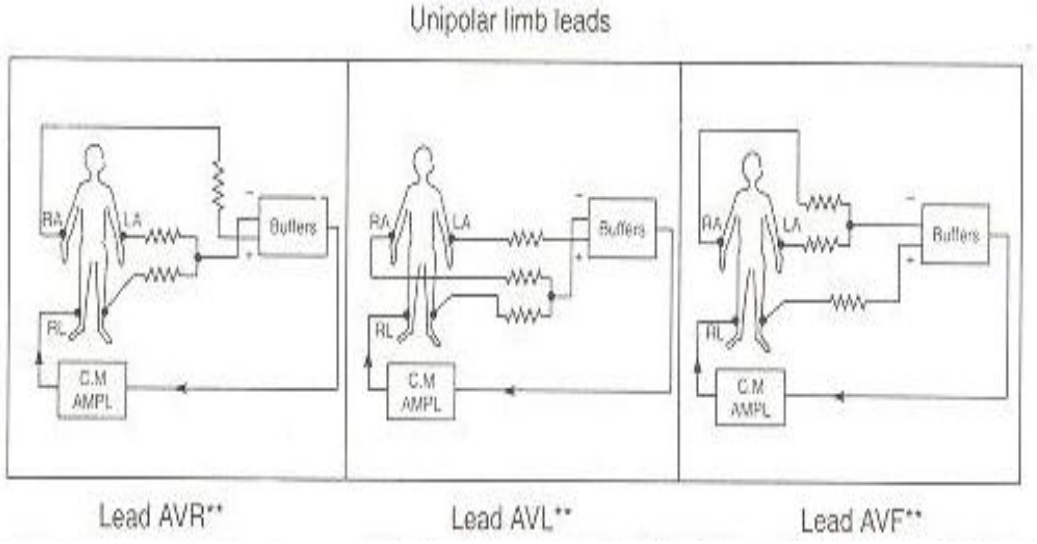
Faults	**Remedies**
The Display Unit –Not a single light is on	There is no signal coming from the backpack. Check that the backpack is connected and the backpack DC OK light Is on. If it is not ON then you probably have a broken coaxial cable — replace the cable with a spare and schedule the broken cable for repair as soon as possible
None of the front panel lights are on	Check the line cord and fuse — at a minimum the green POWER light should be on to show that AC power is applied to the unit and the DC Power Supply is Operational. Note that there are no user adjustments inside the desktop interface Unit. The internal power supply is autosensing and will select the correct AC voltage range - no user adjustment is required
EMG is recorded on any external device.	Check the connecting cable with an oscilloscope to ensure that the cable is correctly connected and that EMG signals are present at the input of the ADC sampling system
Some EMG channels work but others do not have any EMG signals	Check the analog signal connections from the back of the EMG machine desktop unit through to your measuring/recording system. 99% of all ‘lost signal’

04 M

		complaints are due to problems with the analog signal cables and connectors.	
	e)	**Choose the audiometer used for testing of the middle ear and explain it.** **Ans:** **Audiometer used for testing of the middle ear:** Impedance audiometer **Impedance audiometer:** Primary purpose of impedance audiometer is to determine the status of tympanic membrane and the middle ear via tympanometery or known as acoustic immitance test. Acoustic Immittance audiometry is an objective technique which evaluates middle ear function by three procedures: static immittance, tympanometry, and the measurement of acoustic reflex threshold sensitivity Secondary purpose is to evaluate acoustic reflex pathway which include seventh and eighth cranial nerves and brain stem.Thus impedance audiometry is a measurement of energy or air pressure which involves the external auditory canal, the eardrum,ossicular chain,7^{th},8^{th} cranial nerve and brain stem. This test measures the function of the ear drum and the flow of sound through the middle ear. A probe is inserted into the ear and air is pumped through it to change the pressure within the ear as tones are produced.	**02 M** **02 M**
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Draw a block diagram of digital temperature meter and describe it.** **Ans :**  **Fig: Digital temperature indicator** The 7106 IC is used for this indicator. It consists of an Analog to Digital converter, clock generator reference voltage source, BCD to 7 segment decoders, latch display drivers, automatic zero correction and polarity indication. The voltage developed across the sensor is measured as a temperature. The input voltage from the sensor charges the capacitor C4 for a fixed period of time. Then the capacitor discharges, the rate at which the capacitor is discharged being determined by the reference voltage. The actual time it takes for the capacitor to discharge fully is then proportional to the input voltage level. During the discharge period, pulses from an oscillator are stored in a counter, the number of pulses dependent upon the time. The contents of the counter are then displayed on the LCD the oscillator frequency of the IC which is determined by R2 & C3. This frequency	**03 M**

		at 3 samples per second determines the number of samples taken in every second. The IC ensures a zero setting before each measurement automatically. The temperature measurement stage employees three voltage dividers; R10/R11, R8/P1, and R9/P2. The junction of the first divider containing the sensor and R11 is connected to the IN HI input of the IC Variable terminals of the P1 and P2 are connected to the IN LO input and REF HI input respectively. In effect the circuit measures the differential voltage between the one side of the sensor and the variable terminal of P1. As the reference voltage of the IC is also derived from the R9/P2 any measurement is completely independent. R4 and C6 act as an input smoothing filter. The IC 7106 directly drives the display. Gates N1 and N2 activate the low battery indication and decimal pint respectively. The transistor T1 is employed for battery voltage detection. This activates the N1 gate, when battery voltage drops below 7.2 volts. The circuit works on a battery of 9 volts and draws current about 2 m/A. Its response time is about 2 to 3 minutes.	**03 M**
	b)	**An ECG machine is received with following problems. State remedies to eliminate it.** **1. ECG trace too dark** **2. ECG trace too light** **3. ECG signal is noisy** **4. ECG baseline shifting** **5. ECG trace not available** **Ans:** **ECG trace too dark** **Remedies:** Check thermal writing stylus adjustments which affect quality of tracing Check stylus pressure Check stylus heat control knob on front panel and set the knob by rotating it anticlockwise as it decreases the stylus heat. **ECG trace too light** **Remedies:** Check thermal writing stylus adjustments which affect quality of tracing Check stylus pressure and set pressure as recommended. Check stylus heat control knob on front panel (set the knob by rotating it clockwise as it increases the stylus heat) **ECG signal is noisy** **Remedies:** Preamplifier faulty (Replace preamplifier board or faulty components) Loose patient plug connection (Inspect and rectify) **ECG baseline shifting** **Remedies:** Abrade skin Stop patient movement Check ground connections Use same type of electrode at all sites Check for proper cable Check for static build-up **ECG trace not available.** **Remedies:** Check gain control for proper setting. Check brightness control for proper setting. Check lead selector switch. Make certain it is in the "on" position. Are the electrodes dry? If so, replace. Is the correct patient cable being used? Check the lead wires and cables for damage. Use a continuity tester. Check connections: a. Is the patient cable fully inserted into the monitor?	**06 M**

		b. Are the lead wires fully inserted into the patient cable? c. Are the lead wires securely attached to the electrodes?	
	c)	**Choose the instrument used to evaluate the electrical activity in brain and explain various recording techniques' in it.** **Ans:** **The instrument used to evaluate the electrical activity in brain:** EEG machine **Three different recording methods are used in the routine EEG recording:** **Unipolar or Monopolar recording:-**In this method on electrode is made common to all channels. Ears are connected together to form reference common electrode as shown in fig. Apart from ears, sometimes nose tip jaw neck and head tops are also used as reference points. This method is used to record an active potential at only one point on the scalp. The electrode from which no active potential at comes in is called as reference electrode and the electrode from which an active potential comes in is called an active electrode.  **Fig: Unipolar Recording** **Average recording:**- In this technique one input lead of all amplifiers is taken to the common point of a summing network. The summing network is formed by equal resistances of high value.  **Fig: Average recording** **Bipolar recording:-**In bipolar recording method different channels are connected in series between electrode pair as shown in fig. This method records the potential difference between two electrodes on the scalp.  **Fig: Bipolar Recording**	**02 M** **01 M** **01 M** **01 M** **01 M** **(Any two recording techniques consider)**

6.		**Attempt any TWO of the following:**	**12 M**
	a)	**Identify the instrument to measure the non invasive blood pressure and explain the working for it.** **Ans:** **Instrument to measure the noninvasive blood pressure:** In routine clinical tests, blood pressure is usually measured by means of an indirect method using a sphygmomanometer. **Working of sphygmomanometer:** Sphygmomanometers indicate a patient's blood pressure by measuring mean arterial pressure and then calculating systolic and diastolic measurements. The device is composed of a dial, pump, cuff and valve. Once the cuff is inflated, it applies pressure to the brachial artery. The sphygmomanometer cuff is inflated to well above expected systolic pressure. As the valve is opened, cuff pressure (slowly) decreases. When the cuff's pressure equals the arterial systolic pressure, blood begins to flow past the cuff, creating blood flow turbulence and audible sounds. Using a stethoscope, these sounds are heard and the cuff's pressure is recorded. The blood flow sounds will continue until the cuff's pressure falls below the arterial diastolic pressure. The pressure when the blood flow sounds stop indicates the diastolic pressure.Systolic and diastolic pressures are commonly stated as systolic 'over' diastolic. For example, 120 over 80. Blood flow sounds are called Korotkoff sounds.	**03 M** **03 M**
	b)	**Explain unipolar and bipolar lead configurations for ECG with neat diagram.** **Ans:**  **Fig: Unipolar lead configuration** **Unipolar leads:** In unipolar limb leads two of the limb leads are tied together and recorded with respect to the third limb. In lead AVR, the right arm is recorded with respect to common junction of the left arm and left leg electrodes. In lead AVL, the left arm is recorded with respect to the common junction of the right arm and left leg electrodes. In lead AVF, the left leg is recorded with respect to the two arm electrodes tied together. **Bipolar lead configuration**	**02 M** **01 M**

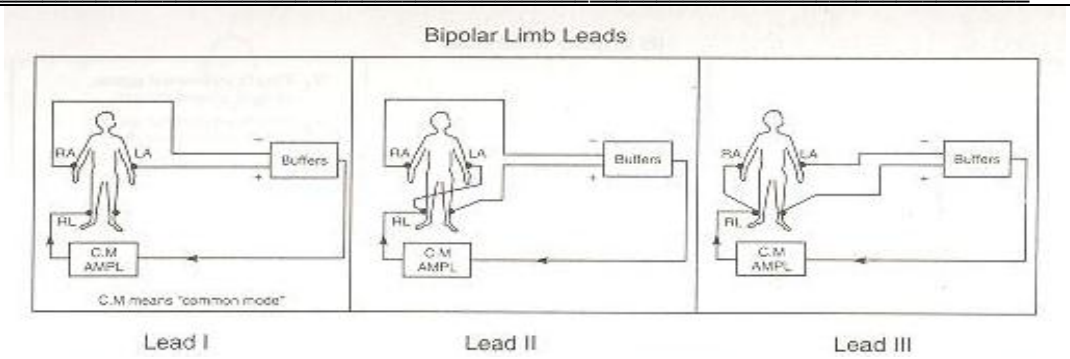


Fig: Bipolar lead configuration — **02 M**

Bipolar lead: In bipolar leads, ECG is recorded by using two electrodes. In standard lead I, the electrodes are placed on the right and the left arm (RA and LA). In lead II, the electrodes are placed on the right arm and the left leg (RA and LL). In lead III, the electrodes are placed on the left arm and the left leg (LA and LL). In all lead connections, the difference of potential measured between two electrodes is always with reference to a third point on the body. This reference point is conventionally taken as the right leg (RL). — **01 M**

c) Draw the preamplifier circuit of EMG and explain it.

Ans:

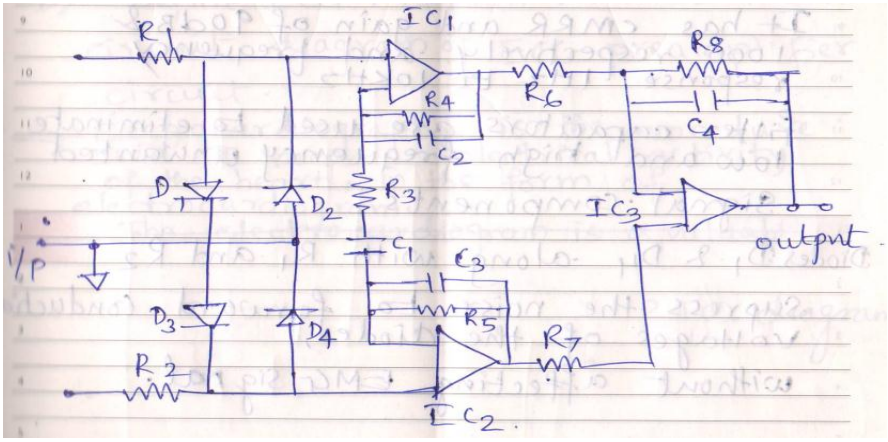


Fig: Preamplifier circuit of EMG — **03 M**

EMG pre- amplifiers are used to produce exceptionally clean waveforms even during human movements while recording. The preamplifier is located near to the entrance.It receives direct input of very small bioelectric signals, and is exposed to influence of noises thus it is designed in such way that it eliminates AC induction interference, polarization voltage generated by electrode and internal noise. It employs three operational amplifiers and forms an instrumentation amplifier. It has CMRR and gain of 90 db& 1000 respectively and frequency response 1 Hz to 10 KHz.Filter capacitors are used to eliminate low and high frequency unwanted signal components.Diodes D1 & D4 along with R1 and R2 suppress the noise to forward conduction voltages of the diodes, without affecting EMG signals. — **03 M**