SUMMER – 2022 EXAMINATION

Subject Name: Fundamentals of Medical Electronics **Model Answer** **Subject Code: 22220**

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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>1.</td><td></td><td>Attempt any FIVE of the following:</td><td>10 M</td></tr>
<tr><td></td><td>a</td><td>List types of components.
Ans:
Types of components:
1. Active components
2. Passive components</td><td>02 M</td></tr>
<tr><td></td><td>b</td><td>State applications of carbon film resistor.
Ans:
Applications of carbon film resistor: (Any Two)
1. Military applications
2. Potential divider and Amplifiers.
3. Radio and TV receivers (low wattage blocks)
4. High frequency, low power application
5. Power supplies and biasing circuits of transistor
6. Zener voltage regulator</td><td>02 M</td></tr>
<tr><td></td><td>c</td><td>Compare fixed capacitor and electrolytic capacitor.
Ans:
<table>
<tr><th>Fixed capacitor</th><th>Electrolytic capacitor</th></tr>
<tr><td>1. Types of fixed capacitor: Electrolytic capacitor, Electrostatic capacitor.</td><td>1. Types of electrolytic capacitor: Aluminium electrolytic capacitor, Tantalum electrolytic capacitor</td></tr>
<tr><td>2. Symbol:
  </td><td>2. Symbol:
  </td></tr>
</table>
Table: Comparison of fixed capacitor and electrolytic capacitor</td><td>02 M</td></tr>
</table>

	d	**List standard values of inductors available in the market. (Any Two)** **Ans:** **Standard values of inductors:** Standard values of inductors typically range from **1 µH (10^{-6} H) to 20 H**.	**02 M**
	e	**Sketch symbol of Schottky diode and LED.** **Ans:**  **Fig: Symbol of Schottky diode**  **Fig: Symbol of LED**	**01 M** **01 M**
	f	**Define ripple factor and efficiency of rectifier.** **Ans:** **Ripple Factor:** Ripple Factor is the ratio of rms value of ac component present in the rectified output to the average of rectified output. It is a dimensionless quantity and denoted by γ. Its value is always less than unity. **Efficiency:** Efficiency is defined as the ratio of dc output power to ac input power of a rectifier.	**01 M** **01 M**
	g	**Give specifications of photodiode.** **Ans:** **Specifications of photodiode: (Any Two)** 1. Wavelength Sensitivity (λP): 940nm. 2. Open Circuit Voltage: 0.39V. 3. Reverse breakdown voltage: 32V. 4. Reverse Light current: 40µA. 5. Reverse Dark current: 5nA. 6. Rise Time/ Fall Time: 45/45nS. 7. View Angle: 80 deg. 8. Package: 5mm.	**02 M**
2.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a	**Compare LDR & TDR.** **Ans:**	**04 M**

Parameter	LDR	TDR
1. Working principle	Resistance value of LDR changes with change in light intensity.	Resistance value of TDR changes with change in temperature.
2. Material used	Calcium sulphide, tallium sulphide, lead sulphide etc.	Oxides of metals such as manganese, cobalt and nickel etc.
3. Applications	Automatic contrast and brightness control in TV. Used in camera light meters, street lights etc.	Automatic temperature control, Fluid flow measurement, Liquid level sensor, Temperature sensing in electric motors and

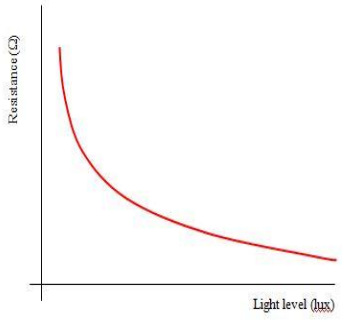
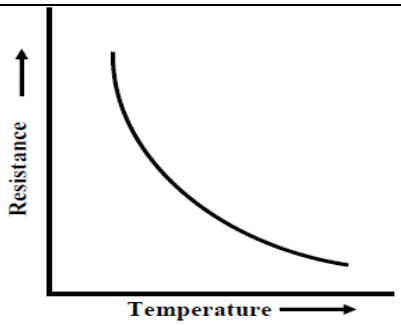
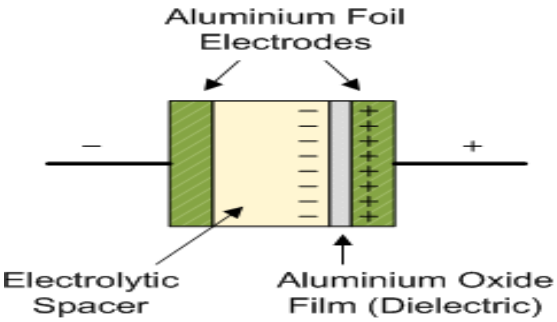
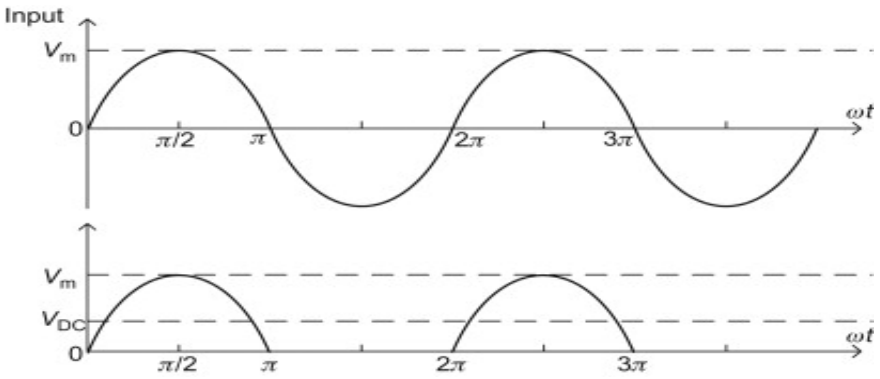
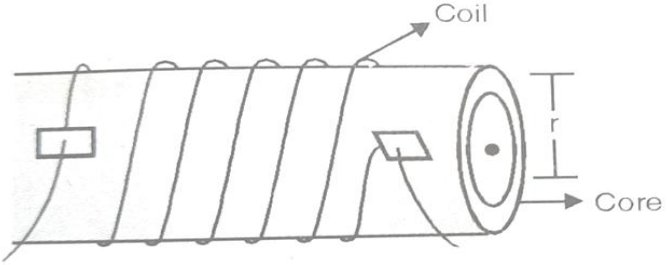
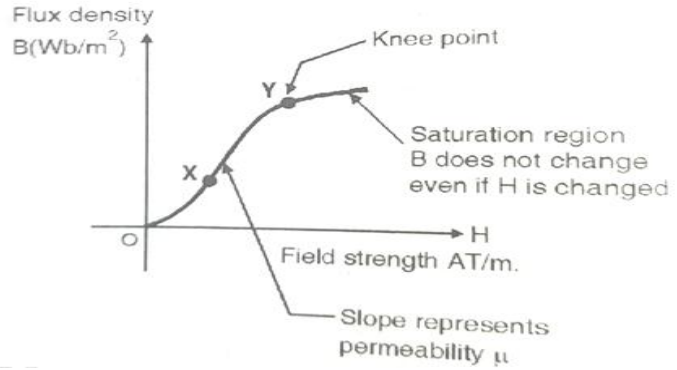
			transformers.	
		4. Characteristic		

Table: Comparison of LDR & TDR

	b	**Explain construction of electrolytic capacitor with sketch. State its specification (any two).** **Ans:**  **Fig: Constructional diagram of electrolytic capacitor** The plates of an electrolytic capacitor are constructed from conducting aluminium foil. As a result they can be made very thin and they are also flexible so that they can be packaged easily at the end of the production process. The two plates or foils are slightly different. One is coated with an insulating oxide layer, and a paper spacer soaked in electrolyte is placed between them. The foil insulated by the oxide layer is the anodes while the liquid electrolyte. The thickness of the anode oxide thin film in an aluminium electrolytic capacitor is selected by the required working withstands voltage. The second foil acts as the cathode and although this does have a naturally occurring oxide layer, this is very much thinner. **Specifications of electrolytic capacitor (Any Two):** 1. Capacitance: 0.47 uF to 10,000 uF 2. Working voltage rating: 3 V to 700V 3. Capacitance tolerance: +80% / -20%	**01 M** **02 M** **01 M**
	c	**Describe working of SMD capacitor. State its applications.** **Ans:** **Working of SMD capacitor:** The term SMD referred to as SMT (surface mounted technology). So the capacitor like SMD can be designed with different technology. The SMD technology manufacturer's capacitors easily so that bulk manufacturing can be done easily. The main function of any SMD capacitor is to charge as well as discharge electrical supply. The designing of this capacitor can be done using metallic plates where these plates are separated by the dielectric material. This capacitor's name mainly depends on the dielectric material used in this capacitor. **Applications of SMD capacitors:** 1. These capacitors are used in different electronics equipment because of their	**02 M**

		less size and ability to be arranged onto a PCB. 2. Thus, SMD capacitors are applicable in almost all locations on mass-generated electronic equipment.	**02 M**
	d	**Explain HWR with input and output waveforms.** **Ans:** The circuit configuration of a half wave rectifier is consists of the step down transformer, R_L is the load resistance and one diode. In the positive half cycle (0-π) of the ac supply, the secondary voltage is positive, Hence the diode is forward biased and starts conducting in positive half cycle. As the diode starts conducting, the secondary voltage appears almost as it is across the load resistance (as the voltage drop across a conducting diode is very small). The load voltage is thus positive and almost equal to the instantaneous secondary voltage. In the negative half cycle of the ac supply (π to 2 π), secondary voltage is negative. Hence the diode is reverse biased and offers a very high resistance. Hence that can be replaced it by an open circuited switch. The load is disconnected from the secondary.  **Fig: Input and output waveforms of HWR**	**02 M** **01 M** **01 M**
3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a	**Explain construction of air core inductor with sketch. State any two applications.** **Ans:** Ceramic core inductors are referred as "Air core inductors". Ceramic is the most commonly used material for inductor cores. Ceramic has very low thermal co-efficient of expansion, so even for a range of operating temperatures the stability of the inductor's inductance is high. Since ceramic has no magnetic properties, there is no increase in the permeability value due to the core material. Its main aim is to give a form for the coil. In some cases it will also provide the structure to hold the terminals in place. The main advantages of these inductors are very low core losses, high Quality factor. These are mainly used in high frequency applications where low inductance values are required.  **Fig: Air core inductor**	**01 M** **02 M**

		Applications of air core inductor: 1. They are used for intermediate or radio frequency (I.F. or R.F.) applications in tuning coils. 2. Inter stage coupling.	**01 M**
	b	**Explain B-H Curve with sketch.** **Ans:** The B-H curve or magnetization curve is the graphical relationship between B and H, with H plotted on the X-axis and B on the Y-axis. Below fig shows the typical magnetization curve. The B-H curve of above fig. can be described by dividing it into 3- regions. **Region OX:** For zero current H = 0 and B is also zero. The flux density B hen increases gradually as the value of H is increased. However B changes slowly in this region. **Region X-Y:** In this region, for small change in H. there is a large change in B. The B-H curve is almost linear in this region. This linearity comes to an end at point Y and the B-H curve starts bending. Point Y is called as the knee point. **Region beyond Y (Saturation Region):** After point Y, the change in B is small even for a large change in H. Finally the B-H curve will tend to be parallel to X axis. This region is called as saturation region which indicates the magnetic flux saturation in the core. That means even if we change I, there will be change in H but no change in B.  **Fig: B-H Curve**	**02 M** **02 M**
	c	**Describe characteristics of Zener diode with sketch.** **Ans:** The V-l characteristics of a Zener diode can be divided into two parts: **1. Forward characteristics:** It is almost identical to the forward characteristics of a p-n junction diode. **2. Reverse characteristics:** As we increase the reverse voltage, initially a small reverse saturation current I_o which is in μA will flow. This current flows due to the thermally generated minority carriers. At a certain value of reverse voltage, the reverse current will increase suddenly and sharply. This is an indication that the breakdown has occurred. This breakdown voltage is called as Zener breakdown voltage or Zener voltage and is denoted by V_z. The value of V_z can be precisely controlled by controlling the doping levels of p and n regions at the time of manufacturing a Zener diode. After breakdown has occurred, the voltage across Zener diode remains constant equal to V_z. Any increase in the source voltage will result in the increase in reverse Zener current. The Zener current after the reverse breakdown must be controlled by connecting a resistor R. This is essential to avoid any damage to the device due to excessive heating.	**02 M**

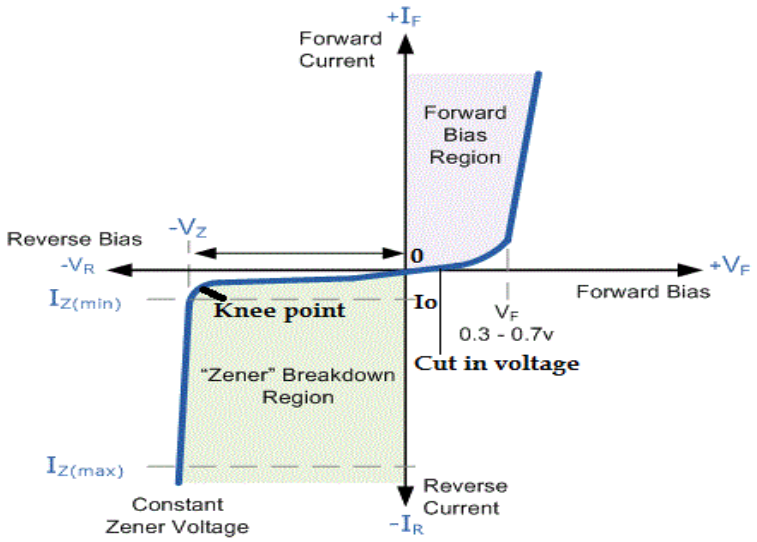


Fig: Characteristics of Zener diode — **02 M**

d **Compare HWR, full wave centre tap and bridge rectifier.** — **04 M**

Ans:

Comparison of HWR, full wave centre tap and bridge rectifier: (Any Four)

Parameter	FWR	Centre tap	Bridge
1. Number of diodes used	One	Two	Four
2. Center tap transformer	Not required	Very much required	Not required
3. Transformer core saturation	Possible	Not possible	Not possible
4. PIV	V_m	$2V_m$	V_m
5. Ripple frequency	50 Hz	100 Hz	100 Hz
6. TUF	28.7%	69.3%	81.2%
7. Maximum rectification efficiency	40%	81.2%	81.2%

Table: Comparison of HWR, full wave centre tap and bridge rectifier

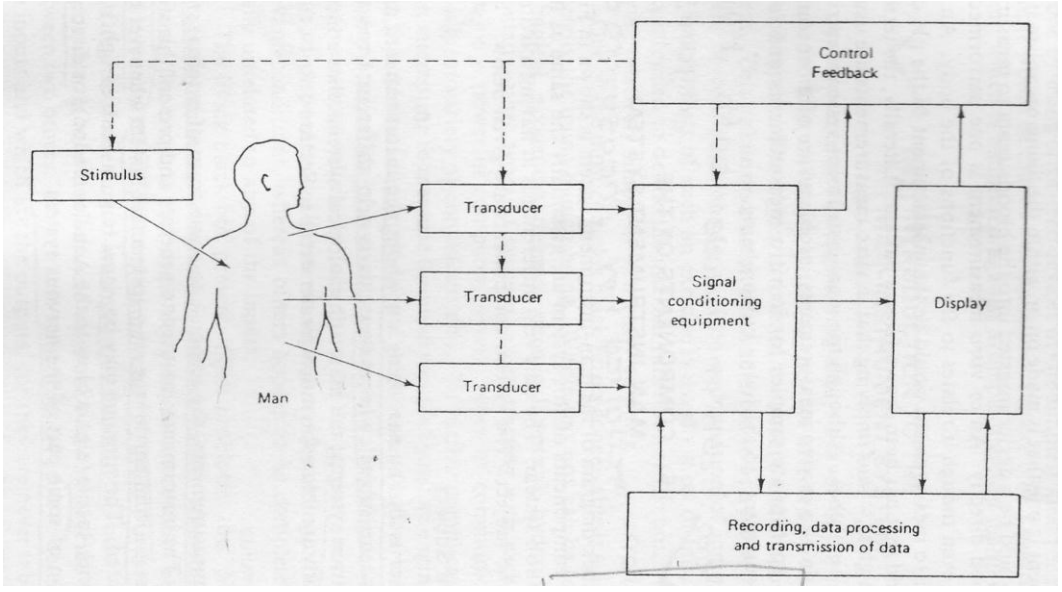
4. **Attempt any <u>THREE</u> of the following:** — **12 M**

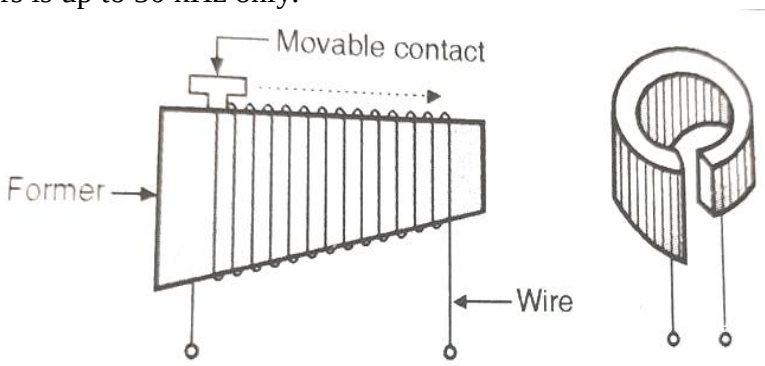
a **Define polarization and depolarization.** — **02 M**

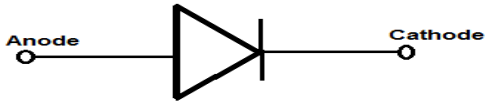
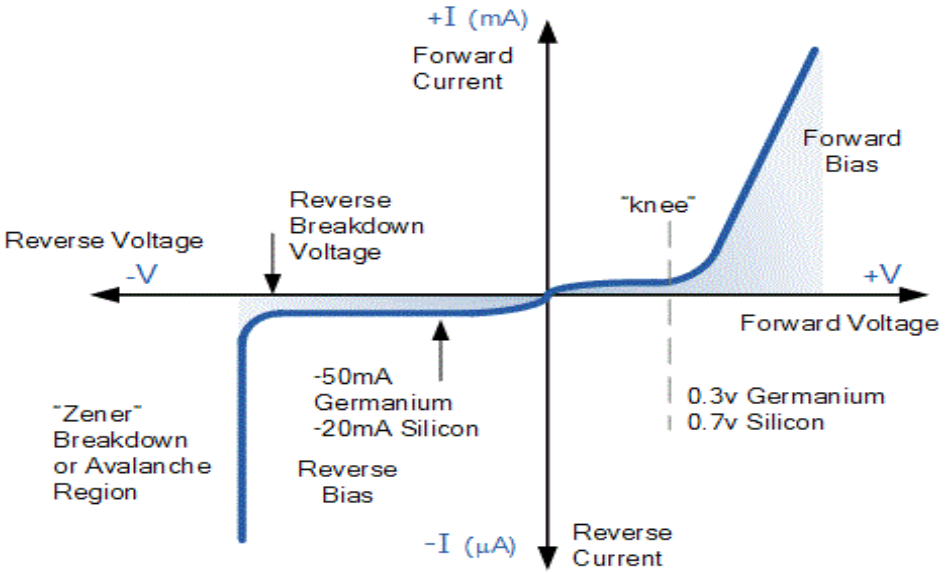
Ans:

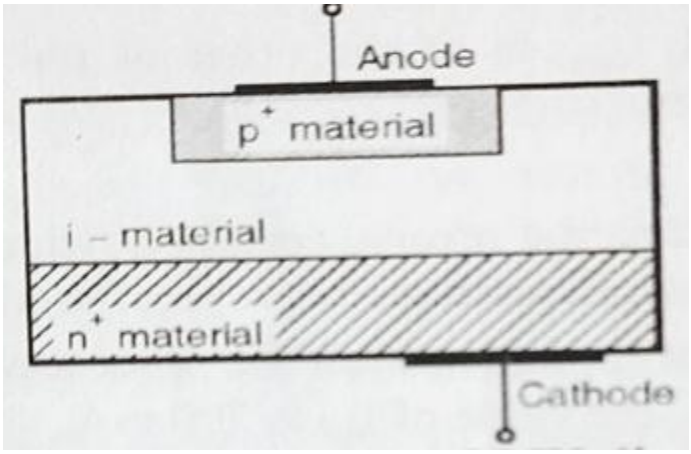
Polarization:

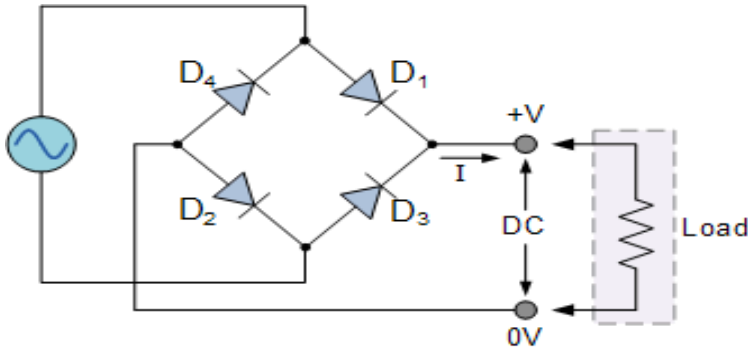
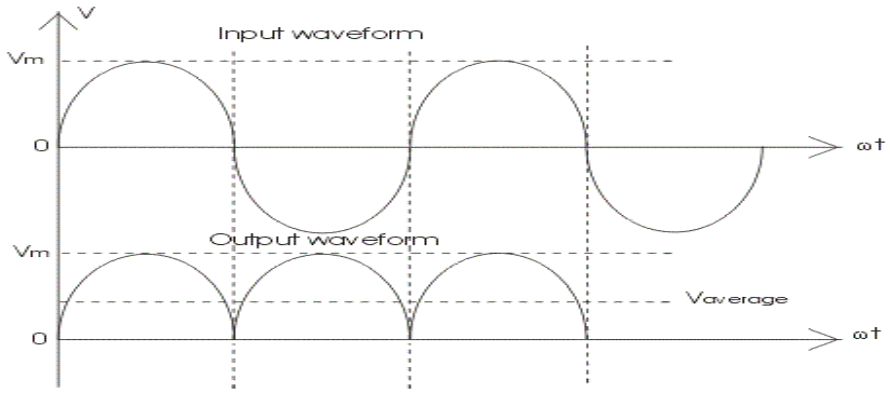
Surrounding the cells of the body are body fluids, which are ionic and which provide a conducting medium for electric potentials. The principle ions are involves sodium, potassium, and chloride. The concentration of the sodium ion more on the outside of the cell membrane than on the inside. Since sodium is a positive ion, in its resting state, a cell has a negative charge along the inner surface of its membrane and positive charge along the outer portion. The unequal charge distribution is a result of certain electrochemical reactions and process occurring within the living cell and potential measured is called the resting potential. The cell in such condition is said to

		be polarized. **Depolarization:** A decrease in this resting membrane potential difference is called depolarization. When the cell is exited or stimulated, the outer side of the cell membrane becomes momentarily negative with respect to the interior. This process is called depolarization and the cell potential changes too approximately +20mv.	**02 M**
	b	**Explain medical instrumentation system with sketch. State its objectives.** **Ans:** 1. **The subject**: The subject is human being on whom the measurements are made. 2. **Stimulus**: The instrument used to generate and present this stimulus to the subject is a vital part of man instrument system when responses are measured. Stimulus may be visual (e. g. flash of light), auditory (e.g. a tone), tactile (e.g. a blow to the Achilles tendon) or direct electrical stimulation of some part of nervous system. 3. **The Transducer:** A device capable of converting one form of energy or signal to another. Here each transducer is used to produce an electrical signal that is analog of the phenomenon. Transducer may measure temperature, pressure, flow or any other variables found in body. 4. **Signal condition equipment:** The part of instrumentation system that amplifies modifies or in any other way changes the electric output of transducer is called signal conditioning Equipment. It also combines or relates the output of two or more transducers output signal is greatly modified with respect to the input. 5. **Display Equipment:** Electric output of signal conditioning equipment must be converted into a form that can be perceived by one of man's senses and can convey information. Obtained by measurement in meaningful way. Input to display device is modified electric signal and its output is some is form of visual, audible or possible tactile information here display equipment may include graphic pen recorder. 6. **Recording Data:** Processing & Transmission equipment - It is often necessary to record the measured information for possible latter use or to transmit it from one location to another on-line digital computer may be part of this system where automatic storage or processing data is required. 7. **Control devices:** A control system is incorporated where it is necessary or desirable to have automatic control of stimulus, transducers or any other part of man instrument system.  **Fig: Medical Instrumentation System**	**01 M** **02 M**

		Objectives of Medical Instrumentation System: 1. **Information Gathering**: In an information gathering system, instrumentation is used to measure natural phenomena and other variables to aid man in his quest for knowledge about himself and the universe in which he lives. 2. **Diagnosis:** Measurements are made to help in the detection and hopefully, the correction of some malfunction. 3. **Evaluation:** Measurements are used to determine the ability of a system to meet its functional requirements. 4. **Monitoring**: it is used to obtain continuous or periodic information about the state of the system. 5. **Control**: Instrumentation is sometimes used to automatically control the operation of a system based on changes in one or more of the internal parameters or the output of the system.	**01 M**
	c	**Describe working of Logarithmic Potentiometer with sketch.** **Ans:** The below fig. shows the logarithmic potentiometer. As shown, the height of the former is not uniform. A tapered strip is taken and the resistance wire is wound on it. After completing the winding, the strip is bent into a round shape as shown in above fig. The desired nonlinear relationship between the position of movable contact and the resistance value is obtained due to the tapered strip used. The desired nonlinear relationship (such as the logarithmic relationship) can be obtained by suitable shaping of the tapered strip used. The logarithmic potentiometers are generally used as volume control potentiometers in radio receivers and music systems. Different resistance values can be obtained by changing the diameter of the wire or spacing between wire turns or core length or type of Wire. Due to coiled wire construction the inductance offered by these potentiometers is high. The maximum operating frequency of these potentiometers is up to 50 kHz only.  **Fig: Logarithmic Potentiometer**	**02 M** **02 M**
	d	**State applications of trimmer capacitor and PVC gang capacitor.** **Ans:** **Applications of trimmer capacitor: (Any Two)** 1. Trimmer capacitors are used in radio receivers. 2. They are used tuning and tracking processes. 3. Trimmer capacitors are used for coil trimming at intermediate radio frequencies. **Applications of PVC gang capacitor: (Any Two)** 1. PVC gang capacitors are used in transistor radio receiver because of their small size. 2. Variable frequency oscillators.	**02 M**

		3. Signal Generators. 4. T.V. Receivers. 5. Tuned amplifiers.	**02 M**
	e	**Show the color bands of resistor with** **i) 10Ω resistance with 5% tolerance and** **ii) 22kΩ with 10% tolerance.** **Ans:** **i) 10Ω resistance with 5% tolerance:** Brown Black Black Gold (For Four Band) **OR** Brown Black Gold (For Three Band) **ii) 22kΩ with 10% tolerance:** Red Red Orange Silver	**02 M** **02 M**
5.		**Attempt any TWO of the following:**	**12 M**
	a	**Draw symbol and V-I characteristics of P-N junction diode. Also explain it.** **Ans:**  **Fig: Symbol of P-N Junction diode**  **Fig: V-I characteristics of P-N Junction diode** 1. **The forward characteristics:** In the forward characteristics, the forward voltage is small and less than the cut in voltage. Therefore the forward current flowing through the diode is small. With further increase in the forward voltage, it reaches the level of the cut in voltage and the width of depletion region goes on decreasing. As soon as the forward voltage equals the cut in voltage, current through the diode increases suddenly. The nature of this current is exponential. The large forward current in the forward characteristics is limited by connecting a resistor 'R' in series with the diode. The forward current is of the order of a few mA. The forward current is a conventional current that flows from anode to cathode. Cut-in voltage (Knee voltage) :	**01 M** **02 M**

		The voltage at which the forward diode current starts increasing rapidly is known as the 'cut-in voltage' of a diode. The cut-in voltage is very close to the barrier potential. Cut-in voltage is also called as knee voltage. Generally a diode is forward biased above the cut in voltage. The cut-in voltage for a silicon diode is 0.6 V and that for a germanium diode is 0.2 V. 2. **The Reverse characteristics:** Reverse Characteristics is a graph of reverse voltage **(**V) versus the reverse current (I). Current flowing through a diode in the reverse biased state is the reverse saturation current which flows due to minority carriers. Therefore it is treated as a negative current. As the reverse voltage is increased. The reverse saturation current remains constant. Reverse saturation current does not depend on reverse voltage but it depends only on temperature. But as the reverse voltage reaches the breakdown voltage value, A large current flows through the diode. Operation in the breakdown region should be avoided because the diode may be damaged due to excessive power dissipation. Typically the reverse breakdown voltage for a p-n junction diode is in the range of 50 to 100 Volts. The resistance of the diode in the reverse biased condition is called as the reverse resistance and its value is very high (of the order of few hundred kΩ).	**03 M**
	b	**Explain working of PIN diode with constructional diagram and state specifications of PIN diode.** **Ans:** The PIN diode is a special type of diode. An intrinsic semiconductor layer (i-layer) is sandwiched between heavily doped P^+ layer and a thin n^+ layer. Hence the name P-I-N diode. This diode is used at microwave frequencies i.e, frequencies above 1GHz. The intrinsic i-layer is actually a high resistivity p-type silicon layer. This region is also called as π region. When this diode is open circuited, electrons will flow from i-region to P^+ region to recombine with the excess number of holes there and holes will flow from i-region to n^+ region to recombine with the excess number of electrons, in the n^+ region.  **Fig: Constructional diagram of PIN Diode** **Specifications of PIN diode:** 1. Operating wavelength: 1100 nm 2. Bandwidth: 2.5 GHz 3. Saturation power: 6dBm 4. Intrinsic layer thickness: 10 to 200 microns	**02 M** **02 M** **02 M**

	c	**Explain role of engineers in healthcare industry.** **Ans:** **Role of engineers in healthcare industry: (Any Six)** 1. Designing medical instrument 2. Contribute in the development, manufacturing and testing of medical products. 3. Maintain and enhance life of medical instrument. 4. Designing prostheses. 5. Designing replacement parts for people. 6. Creating systems to allow the handicapped to function and communicate. 7. Managing the technology in the hospital system. 8. Saling biomedical instruments.	**06 M**
6.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a	**Explain bridge rectifier with circuit diagram and input output waveforms.** **Ans:** A bridge rectifier is a type of full wave rectifier which uses four or more diodes in a bridge circuit configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC). The four diodes labeled D_1 to D_4 are arranged in "series pairs" with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below. During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before.  **Fig: Circuit diagram of bridge rectifier**  **Fig: Input output waveforms of bridge rectifier**	**02 M** **02 M** **01 M** **01 M**

b **State the primary signal characteristics of ECG, EEG and EMG.** — **06 M**

Ans:

Electrocardiography (ECG)	Frequency range: 0.05 to 120 Hz Signal amplitude: 0.1 to 5 µV Typical signal: 1 µV
Electroencephalography (EEG)	Frequency range: 0.1 to 100 Hz Signal amplitude: 2 to 200 µV Typical signal: 50 µV
Electromyography (EMG)	Frequency range: 5 to 2000 Hz Signal amplitude: 0.1 to 5 µV

Table: Primary signal characteristics of ECG, EEG and EMG

c **Compare iron core inductor and air core inductor. Give the applications of each.** — **04 M**

Ans:

Iron core	Air core
1. Iron core inductor consists of coil wound over a solid or laminated iron core.	1. Air core inductors, a core is made up of ceramics, plastic or cardboard type insulating material. The conductive wire is wound on this core hence there is air inside the coil.
2. Q factor is high.	2. Q factor is low.
3. Cost is high.	3. Cost is low.
4. Symbol: 	4. Symbol: 

Table: Comparison of iron core inductor and air core inductor

1. **Applications of iron core inductor:** — **01 M**
   1. Iron core inductors are used in filter circuit.
   2. They are also used in A.F. applications.
2. **Applications of air core inductor:** — **01 M**
   1. They are used for intermediate or radio frequency (I.F. or R.F.) applications in tuning coils.
   2. Inter stage coupling.