# MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

## SUMMER– 2018 EXAMINATION

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 the 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, the examiner may give credit for principal components indicated in the figure. The figures drawn by the 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 the model answer.
6) In case of any questions credit may be given by judgement on the part of examiner of relevant answer based on candidate's understanding.
7) In 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) | **Give the classification of components.**<br>**Ans:**<br>i) Active components<br>ii) Passive components | **1 mark each** |
| | b) | **State the material used for resistors.**<br>**Ans:**<br>i) Ceramic ii) Glass iii) Nichrome iv) Carbon composition v) Carbon film cermet vi) cobalt Vii) Nickel | **1 mark each** |
| | c) | **List any two types of a capacitors.**<br>**Ans:**<br>i) fixed capacitor ii) Variable capacitor iii)Electrostatic capacitor iv) Electrolytic capacitor v) Ceramic capacitor vi) Mica capacitor Vii) Paper capacitor viii) Plastic capacitor | **1 mark each** |

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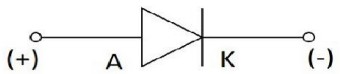
| | **d)** | **Write any two application of magnetic materials.**<br>**Ans:**<br>i) Electrical motors ii) Power iii) Transformer iv) Generator v) Permanant magnet vi) Data storage equipment vii) Other electrical equipment | **1 mark each** |
| | **e)** | **Give the classification of semi-conductor.**<br>**Ans:**<br>i) Intrinsic Semiconductor.<br>ii) Extrinsic semiconductor.<br>- N-type<br>- P-type | **2M** |
| | **f)** | **Define rectifiers**.<br>**Ans:-**<br>A rectifier is an electrical device that converts an Alternating Current (AC) into a Direct Current (DC) by using one or more P-N junction diodes. | **2M** |
| | **g)** | **Draw symbols of : i) PN junction diode ii) Zener diode**<br>**Ans:**<br>i) PN junction diode<br>  <br>Symbol of a Diode<br>ii) Zener diode<br>  | **1 M**<br>**1M** |
| **2.** | | **Attempt any <u>THREE</u> of the following:** | **12 M** |
| | **a)** | **Compare linear potentiometer and logarithmic potentiometer.**<br>**Ans:** | **2M for each** |

| **Sr no.** | **Linear potentiometer** | **Logarithmic potentiometer.** |
|---|---|---|
| 1 | A linear pot has a resistive element of constant cross-section, resulting in a device where the resistance between the wiper and one end terminal is proportional to the distance between them. | A log pot has a resistive element that either 'tapers' in from one end to the other, or is made from a material whose resistivity varies from one end to the other. |
| 2 | Used to adjust the centering of the display on an analog cathode-ray oscilloscope. | Used in connection with audio amplifiers, as human perception of audio volume is logarithmic. |

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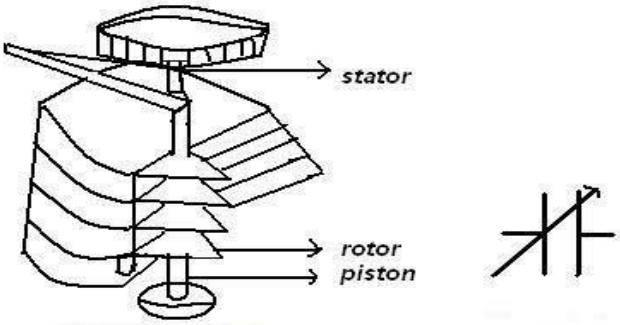
| | **b)** | **Explain air ganged capacitor with its constructional diagram.**<br>**Ans:**<br>  <br><br>**Fig : Air Ganged Capacitor**<br>Air ganged capacitors are capacitors which use air as the dielectric medium located between conductive plates. Air ganged capacitors are capacitors which use air as their dielectric. The simplest Air ganged capacitors are made of two conductive plates separated by an air gap. Air ganged capacitors can be made in a variable or fixed capacitance form. Fixed capacitance Air ganged capacitors are rarely used since there are many other types with superior characteristics. One set is fixed and the other is attached to a shaft which allows the user to rotate the assembly, therefore changing the capacitance as needed. The larger the overlap between the two sets of plates, the higher the capacitance. The maximum capacitance state is achieved when the overlap between the two sets of plates is highest, while the lowest capacitance state is achieved when there is no overlap. | **Diagram = 2M**<br>**Explanation = 2M** |
| | **c)** | **Explain the colour coding scheme for capacitors.**<br>**Ans:** | **4M** |

| Band | Digit | Digit | Multiplier | Tolerance | Tolerance |
|---|---|---|---|---|---|
| Colour | A | B | D | (T) > 10pf | (T) < 10pf |
| Black | 0 | 0 | x1 | ± 20% | ± 2.0pF |
| Brown | 1 | 1 | x10 | ± 1% | ± 0.1pF |
| Red | 2 | 2 | x100 | ± 2% | ± 0.25pF |
| Orange | 3 | 3 | x1,000 | ± 3% | |
| Yellow | 4 | 4 | x10,000 | ± 4% | |
| Green | 5 | 5 | x100,000 | ± 5% | ± 0.5pF |
| Blue | 6 | 6 | x1,000,000 | | |
| Violet | 7 | 7 | | | |
| Grey | 8 | 8 | x0.01 | +80%,-20% | |
| White | 9 | 9 | x0.1 | ± 10% | ± 1.0pF |
| Gold | | | x0.1 | ± 5% | |
| Silver | | | x0.01 | ± 10% | |

**d) Compare low pass filter and high pass filter.** — **4M**

**Ans:**

| Sr no | Low pass filter | High pass filter |
|---|---|---|
| 1 | It is a circuit which allows the frequency below the cutoff frequency to pass through it. | It is a circuit which allows the frequencies above the cutoff frequency to pass through it. |
| 2 | It consists of resistor followed by a capacitor. | It consists of Capacitor followed by a resistor. |
| 3 | It is significant in removing aliasing effect. | It is significant when the distortion due to low frequency signal such as noise is to be removed. |
| 4 | Lower than the cutoff frequency. | Higher than the cutoff frequency. |
| 5 | Communications circuit as anti-aliasing filter. | Audio amplifiers, low noise amplifiers etc. |

**3. Attempt any THREE of the following :** — **12 M**

**a) Show the hysteresis curve for soft and hard magnetic materials.** — **4M**

**Ans:**

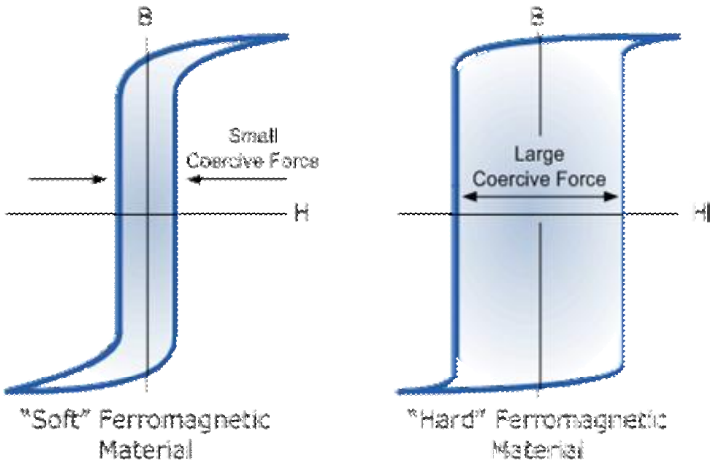



**Fig : Hysteresis Curve**

**b) How inductors are classified on the basis of frequency ?** — **1M**

**Ans:**

There are different types of inductors. Depending on the basis of frequency they are basically categorized as follows:

i) Air core inductor
ii) Iron Core Inductor
iii) Ferrite Core Inductor

**i) Air Core Inductor** — **1M**

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

| | | | |
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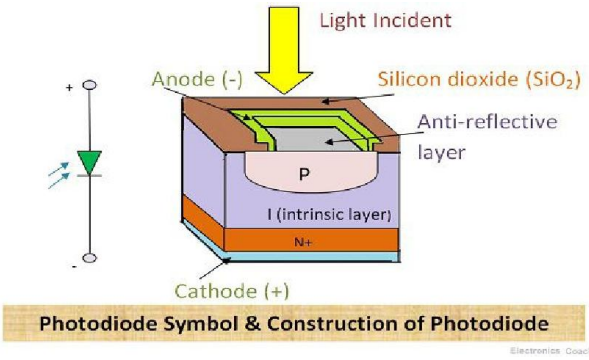
| | | inductor's inductance is high. Since ceramic has no magnetic properties, there is no increase in the permeability value due to the core material.Its main aim is to give a form for the coil. In some cases it will also provide the structure to hold the terminals in place. The main advantage of these inductors are very low core losses, high Quality factor. These are mainly used in high frequency applications where low inductance values are required.<br>**ii) Iron Core Inductor**<br>In the areas where low space inductors are in need then these iron core inductors are best option.These inductors have high power and high inductance value but limited in high frequency capacity. These are applicable in audio equipments. When compared with other core indictors these have very limited applications.<br>iii) **Ferrite Core Inductor**<br>Ferrite is also referred as ferromagnetic material. They exhibit magnetic properties. They consist of mixed metal oxide of iron and other elements to form crystalline structures . The general composition of ferrites is XFe2O4. Where X represents transition materials. Mostly easily magnetized material combinations are used such as manganese and zinc (MnZn), nickel and zinc (niZn).Ferrites are mainly two types they are soft ferrites and hard ferrites. These are classified according to the magnetic coercivity. Coercivity is the magnetic field intensity needed to demagnetize the ferromagnetic material from complete saturation state to zero. | **1M**<br><br>**1M** |
| | **c)** | **Explain the construction of photodiode with sketches.**<br>**Ans:**<br>  <br><br>Photodiode Symbol & Construction of Photodiode<br>The photodiode is made up of two layers of P-type and N-type semiconductor. In this, the P-type material is formed from diffusion of the lightly doped P-type substrate. Thus, the layer of P+ ions is formed due to the diffusion process. And N-type epitaxial layer is grown on N-type substrate. The P+ diffusion layer is developed on N-type heavily doped epitaxial layer. The contacts are made up of metals to form two terminal cathode and anode. The front area of the diode is divided into two types that are active surface and non-active surface. The non-active surface is made up of $SiO_2$ (Silicon di Oxide) and the active surface is coated with anti-reflection material. The active surface is called so because the light rays are incident on it. While on the non-active surface the light rays do not strike. The active layer is coated with anti-reflection material so that the light energy is not lost and the maximum of it can be converted into current. The entire unit has dimensions of the order of 2.5 mm. | **Diagram = 2M**<br><br>**Explanation =2M** |

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| | **d)** | **An ac supply of 230 V is appied to half wave rectifier circuit through a transformer turns ratio 10:1.Find d.c. output voltage and PIV of a diode.**<br>**Ans:**<br>Given Data:<br>V1=230volts; N2/N1=1/10<br>**i) DC output voltage:**<br>We know that the secondary voltage,<br>$V_2=V_1*(N_2/N_1)=230*(1/10)=23V$<br>And maximum value of secondary voltage,<br>$V_{m=}\sqrt{2}*V_2=\sqrt{2}*23=32.5V$<br>Therefore,DC output voltage,<br>Vdc = 0.318Vm = 0.318*32.5 = **10.3V.**<br>ii) **PIV of a diode:**<br>We also know that peak-inverse voltages of a diode,<br>PIV = Vm =**32.5V .** | **2M**<br>**2M** |
| **4.** | | **Attempt any <u>THREE</u> of the following :** | **12 M** |
| | **a)** | **Define: i) ECG ii) EEG**<br>**Ans:**<br>i) **ECG (Electrocardiogram):** A recording of the electrical activity of the heart. Electrodes are placed on the skin of the chest and connected to a machine that, when turned on, measures electrical activity the heart. Output usually appears on a long scroll of paper that displays a printed graph of activity on a computer screen.<br>ii) **EEG (Electroencephalogram):** A recording of the electrical activity of the brain. Electrodes are attached on the scalp and connected to a machine that, when turned on, measures electrical activity of the brain. Output usually appears on a long scroll of paper that displays a printed graph of activity on a computer screen. | **2M**<br>**2M** |
| | **b)** | **Describe basic medical instrumentation system with its sketch.**<br>**Ans:**<br>System components are given below:-<br>i) The subject – The subject is human being on whom the measurements are made.<br>ii) 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.<br>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.<br>iii) The Transducer – A device capable of converting one form of energy or signal to | **2M** |

| | | | |
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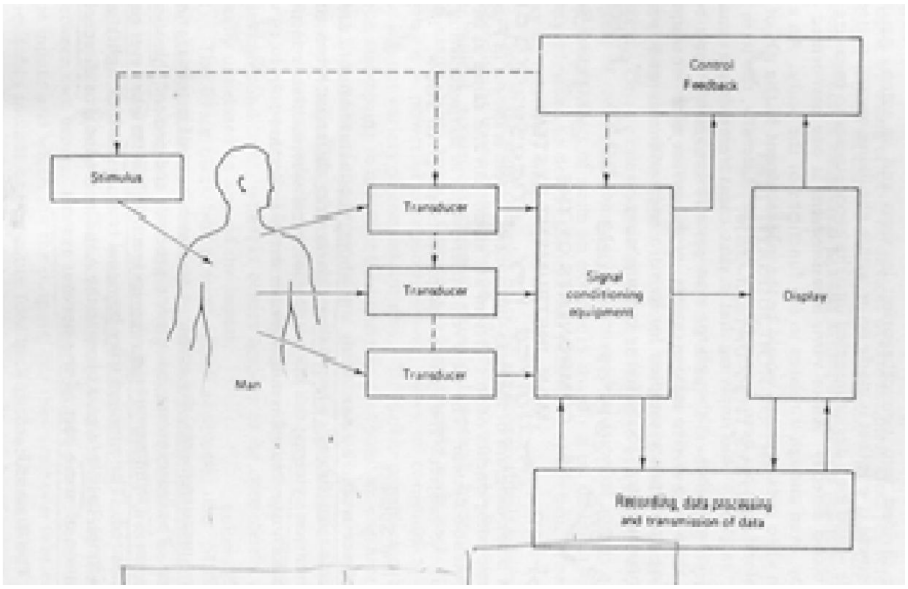
| | | another. Here each transducer is used to produce an electrical signal that is analog of the phenomenon. Transducer may measure temperature, pressure, flow or any other variables found in body.<br>iii) Signal condition equipment – The part of instrumentation system that amplifies modifies or in 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.<br>iv) Display Equipment –<br>Electric output of signal conditioning equipment must be converted into a form that can be perceived by one of mans 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.<br>v) Recording Data – Processing & Transmission equipment -<br>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 mau be part of this system where automatic storage or processing data is required.<br>vi)Control devices –<br>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.<br>  <br><br>**Fig : Man Instrumentation system.**<br>**OR Any other relevant diagram.** | **2M** |
| | **c)** | **Write the colour codes for following resistors:**<br>**i) 560 kΩ, ± 05%** **ii) 43 kΩ, ± 10%**<br>**Ans:**<br>1) Green, Blue, Violt, Gold<br>2) Yelloe, Orange, Green, Silver | **2m**<br>**2m** |

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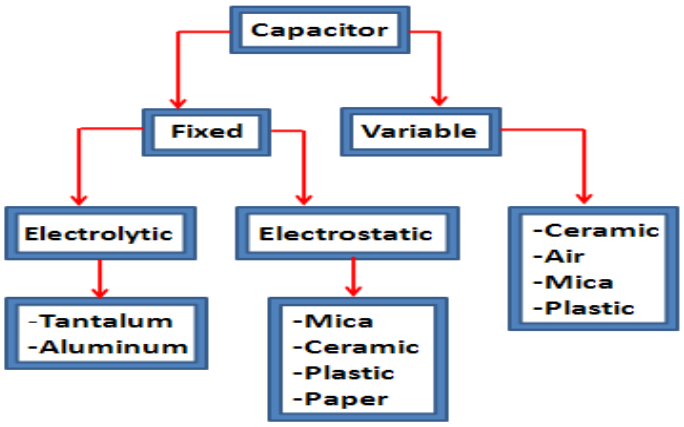
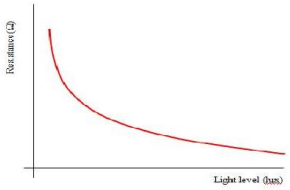
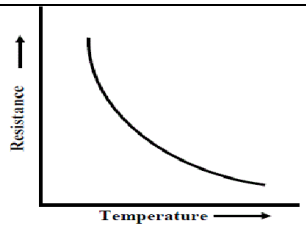
| | **d)** | **Classify capacitors.Also state different materials used for capacitors.**<br>**Ans:**<br>  <br><br>**Different material used in capacitorsas follows :**<br>i. Mica<br>ii. Paper<br>iii. Glass<br>iv. Ceramic<br>v. Plastic film<br>vi. Oxide layer | **2M**<br><br>**2M** |
| | **e)** | **Distinguish between Light Dependent Resistor (LDR) and Temperature Dependent Resistor (TDR).**<br>**Ans:** | **4M** |

| **Sr no** | **Light Dependent Resistor (LDR)** | **Temparature Dependent Resistor (TDR)** |
|---|---|---|
| 1 | LDR is a device that has a resistance change with light intensity | TDR is a device that has a resistance changes with temperature. |
| 2 | When light intensity increases, its resistance decreases. | When temperature increases, the resistance of thermistor decreases. |
| 3 | It could be used to activate a burglar alarm,switch on the street lamp, Camera shutter control | It could be used to activate a fire alarm, switch on a heater |
| 4 |  <br> |  <br> |

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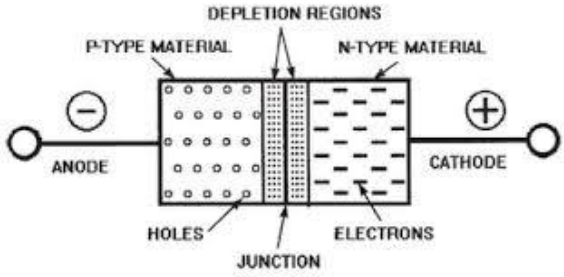
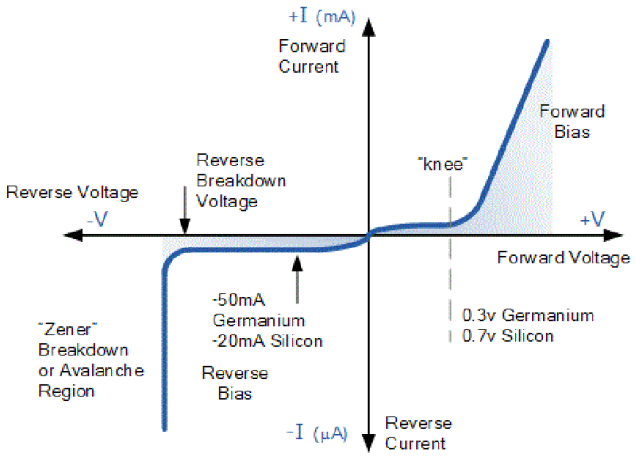
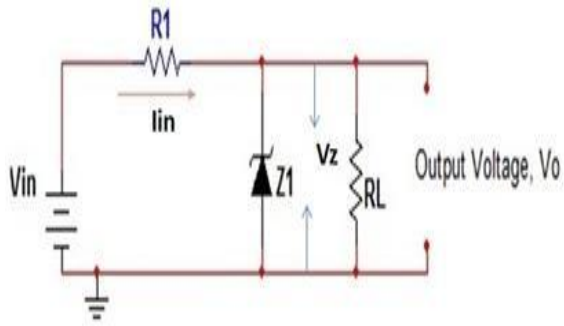
| **5.** | | **Attempt any <u>TWO</u> of the following:** | **12 M** |
| | **a)** | **Explain construction of PN Junction diode. Also draw its V-I characteristics.**<br>**Ans:**<br>  <br><br>PN Junction diode is a device made of two semiconductor material joined together with the required amount of impurity. These materials are N-type, having electrons are majority carrier and P-type material, having holes are majority carrier.<br>  <br><br>**Fig : V-I characteristics of PN Junction diode.** | **3M**<br><br>**3M** |
| | **b)** | **List the applications of zener diode and explain any one in brief.**<br>**Ans:**<br>1. Zener diodes are used in Voltage stabilizers (or) shunt regulators<br>2. used in Surge suppression circuitry for device protection<br>3. used in Over voltage protection circuits.<br>4. Zener diodes are used in clipping and clamping circuits especially peak clippers .<br>5. They are used as Reference elements.<br>6. Used in switching applications.<br>1.Zener diodes are used in **Voltage stabilizers** (or) shunt regulators<br>  <br> | **3M** |

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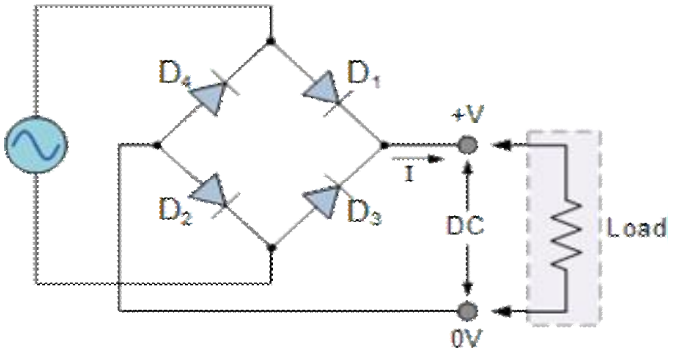
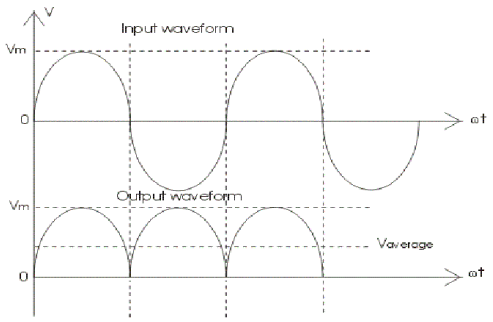
| | | A simple circuit involving Zener diode as a regulator requires a resistor of low value connected in series with the input voltage source. The low value is required so as to allow the maximum flow of current through the diode, connected in parallel. However, the only constraint being, the current through zener diode should not be less than minimum zener diode current. Simply put, for a minimum input voltage and a maximum load current, the Zener diode current should always be $I_{zmin.}$<br>While designing a voltage regulator using zener diode, the latter is chosen with respect to its maximum power rating. In other words, the maximum current through the device should be:-<br><br>$I_{max}$ = Power/Zener Voltage<br>Since the input voltage and the required output voltage is known, it is easier to choose a zener diode with a voltage approximately equal to the load voltage, i.e. Vz ~=$V_o$.<br>The value of the series resistor is chosen to be<br>R =($V_{in}$ – $V_z$)/($I_{zmin}$ + $I_L$), where $I_L$ = Load Voltage/Load resistance. | **3M** |
| | **c)** | **Describe different sources of biomedical signals.**<br>**Ans:**<br>**1. Bio-electric signals:-** These are unique to the biomedical system. They are generated by nerve cells and muscle cells. Their basic source is the cell membrane potential. The most common examples of bioelectric signal are the ECG and EEG.<br>**2. Bio-acoustic signals:** These signals are obtained from sounds created by Biological system and provide information about underlying phenomenon .Eg. Flow of blood in heart through valves, flow of air in lungs.<br>**3. Bio-mechanical signals:-**These signals are obtained from mechanical function of biological system it includes all types of motion and displacement signal.Eg.Motion of chest wall.<br>**4. Bio-chemical signals: -** These types of signals are obtained from the measurements of chemical compositions. Eg- composition of various ions, partial pressure of oxygen or co2 in living tissues or from sample.<br>**5. Bio-magnetic signals:-**In bioelectric signals, some organs produce very weak electromagnetic signals; measurement of these signals is called “Bio-magneticsignals.”<br>**6. Bio-optical signal:-** These signals are generated as result of optical function of the biological system, occurring either naturally or induced by the measurement process. Eg.blood oxygenation may be estimated by measuring the transmitted /back scattered light from a tissue at different wavelength.<br>**7. Bio-impedance signal:-** The impedance of the tissue is a source of important information concerning its composition, blood distribution and blood volume etc.The measurement of galvanic skin response is typical example of this type of signal. | **Any 3 ( 2M each )** |
| **6.** | | **Attempt any <u>TWO</u> of the following:** | **12 M** |
| | **a)** | **Draw bridge rectifier circuit and explain its working with neat waveforms.**<br>**Ans:**<br>**Bridge rectifier definition :**<br><br>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 AlternatingCurrent (AC) into Direct Current (DC). | |




2M

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.

2M




2M

**b) Classify medical equipment. Give two examples of each.**

**Ans:**

**Classification :**

1. Diagnostic equipment
2. Analytical equipment
3. Imaging equipment
4. Therapeutic Equipment

2 M

**Examples :**

**1. Diagnostic equipment**:

**Ex**.ultrasound machine, MRI machines, Positron emission tomography (PET), CT scan machine, and x-ray machines.

**2. Analytical equipment:**

**Ex**.spectrophotometer, oxygen analysers, gas chromatographs, fluorometer,

**3. Imaging equipment:**

**Ex.** X-ray radiography, Magnetic resonance imaging, Medical ultrasonography or ultrasound, Thermography, Positron emission tomography (PET) and Single-photon emission computed tomography (SPECT).

**4. Therapeutic Equipment:**

**Ex**.CPM, Traction machine, short wave diathermy, micro wave diathermy, ultrasound therapy unit, Electrotherapy machine, Nerve muscle stimulator.

4 M

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| | **c)** | **List different types of losses in inductors. Explain any one in detail.**<br>**Ans:**<br>Types of losses of inductor as follows :<br>i) Hysteresis loss<br>ii) Eddy current losses<br>iii) Core losses<br>**i) Hysteresis loss:-** is due to the reversal of magnetization of transformer core whenever it is subjected to alternating nature of magnetizing force .Whenever the core is subjected to an alternating magnetic field, the domain present in the material will change their orientation after every half cycle. The power consumed by the magnetic domains for changing the orientation after every half cycle is called Hysteresis loss.<br>**ii) Eddy currents**:-When an alternating magnetic field is applied to a magnetic material an emf is induced in the material itself according to Faraday's Law of Electromagnetic induction. Since the magnetic material is a conducting material, these EMFs circulate currents within the body of the material. These circulating currents are called Eddy Currents. They will occur when the conductor experiences a changing magnetic field. As these currents are not responsible for doing any useful work, and it produces a loss ($I^2R$ loss) in the magnetic material known as an Eddy Current Loss.<br>**iii) Core losses:-** This category includes any losses in addition to eddy-current and hysteresis losses. This can also be described as broadening of the hysteresis loop with frequency. Physical mechanisms for anomalous loss include localized eddy-current effects near moving domain walls. | **Types = 2M**<br><br>**4M (any one)** |