[120BM0014]

ANALOGUE AND DIGITAL ELECTRONICS

(1) Biopotential Amplifier are specially designed amplifiers for processing physiological electric signals. As these signals from the body are generally low in amplitude, these help in getting a decent amplitude output for analysing the body functioning

a) High input impedance - they have high impedance to avoid excessive loading and which stop from resulting in signal distortions.

Generally they range from 2MΩ to 10MΩ.

Low Output Impedance - They should have low output impedance so that the load is minimal and goes with minimal distortions resulting in preventing macro or micro electric shocks to the patient.

b) Frequency appropriate to signal - the bio amplifier should be protected from interferences and should work on specified bandwidth to actually work better ranging from 0.16 Hz to 250 Hz.

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1) Isolation Circuit - they help in protecting people from minor shocks. The isolation and protection circuit helps the patient from any leakage current from Operated equipment and also High Transients caused by equipments.

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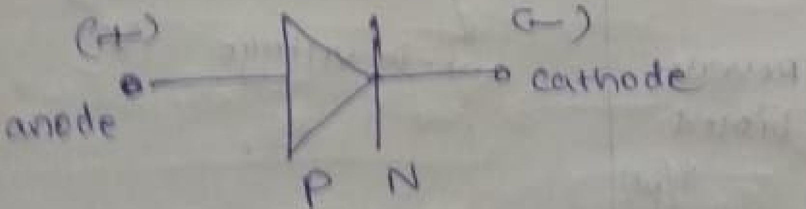
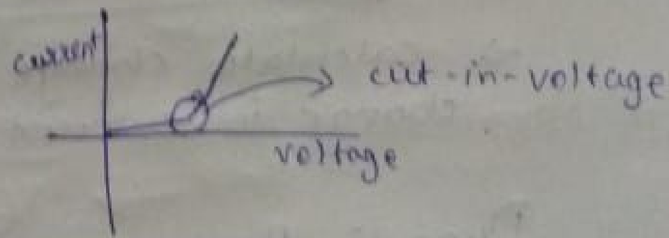
2) The main purpose of a diode is to check the current flow, basically acts as an electric valve. It allows one directional flow of electric current by allowing in one direction and blocking in the other direction.



- Cut-in-voltage = The minimum amount of voltage required for conducting the diode is known as "cut-in-voltage". From this voltage the current starts increasing rapidly.



$$\boxed{I = I_0 \left(e^{\frac{qV}{\eta KT}} - 1 \right)}$$

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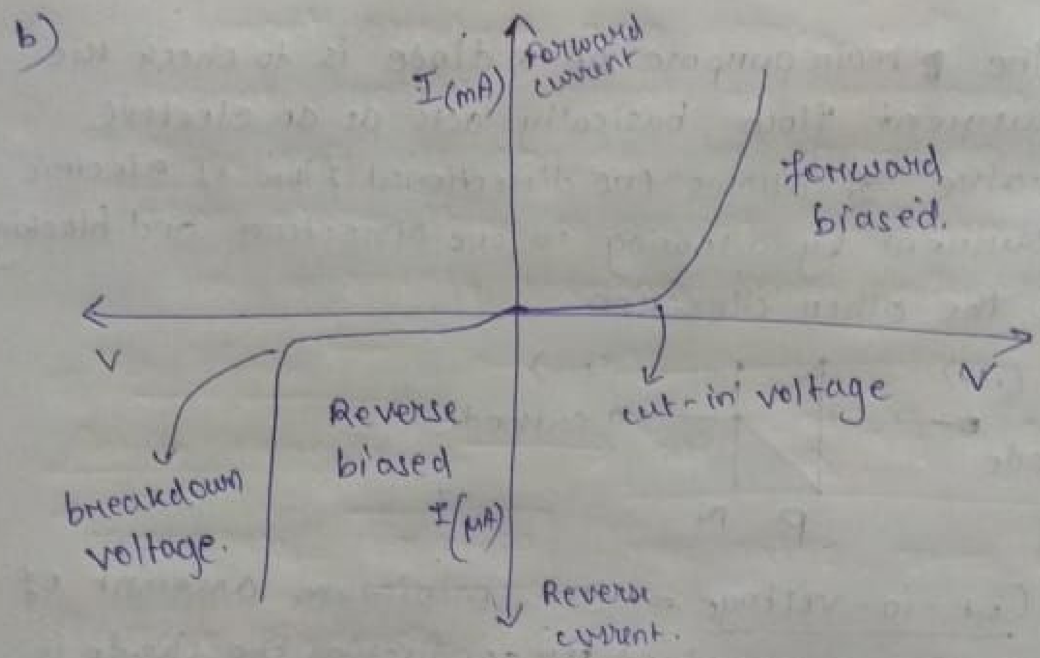
a) Reverse saturation current and bias current are temperature dependant. Rise in temperature increases electron-hole pairs and hence increases conductivity. Thus if we keep voltage constant and increase temp then current increases. For every 10°C increase, the reverse current may double for silicon & germanium.

b)



c) For, <u>Static Resistance</u>

→ calculate change in voltage for change in current. $\left[V/I \right]$

<u>Dynamic Resistance</u>

→ calculate the increase in voltage to increase in current $\left[dV/dt \right]$

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d) Diodes can be used as clipper gates, logic gates, rectifiers, inverters, even act as switch.

- Zener diode - schottky diode - Rectifier diode.
- Light emitting diode - Photodiode - P-N junction diode - Laser diode.

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(4) $v_1^- = V_S \times \frac{R+\Delta R}{(R+\Delta R)+R} = V_S \frac{R+\Delta R}{2R+\Delta R}$

$V_{out} = k(V_2 - V_1)$

$= k(V_1^+ - V_1^-)$

$V_{out} = k\left(\frac{V_S}{2} - V_S\left(\frac{R+\Delta R}{2R+\Delta R}\right)\right)$

$V_{out} = k V_S \left(\frac{1}{2} - \frac{R+\Delta R}{2R+\Delta R}\right)$

$k = \frac{R_f}{R_i}$
(gain)

- Here ideal op-amp is used where

$R_i = \infty$

(gain) $A = \infty$ $(10^5 - 10^6)$

$R_y = 0$

Band width $= \infty$ (infinite Range)

Virtual ground..

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(3) $R_i = 10\,MW$

$R_{cm} = 400\,MW$

$V_{out} = A_d \times V_{id} + R_{cm} \times V_{cm}$.

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AC - a current where flow of electricity changes direction back and forth at regular intervals in cycles.

DC - the current is one-directional consistently

DC

Inductor - it initially works as open circuit then works as short circuit.

Capacitor - initially works as short circuit and then as short circuit and blocks DC current.

AC

Inductor - current will lag and average of current flow is 0 in pure inductor.

Capacitor - current will lead with phase difference of 90°.

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⑥ Active filters

- filters which consists of components like Transistors along with resistors & capacitors are active filters.

Passive filters

- These filters are made up of passive components of circuit like inductors,

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5. Active components

- They control the flow of current.
generate energy for any device and is the core component to operate any device.
It amplifies the power of a signal.

Passive Components

- Cannot produce any energy and cannot control current on their own
Does not use any external energy to run other than the present AC current.
Used in energy storage, phase shifting etc.

Active example

$$\boxed{V_{out} = \left(-\frac{R_f}{R_i}\right) \times V_1 + \left[1 + \frac{R_f}{R_i}\right] V_2}$$

Transistors, $\boxed{\text{Op amps}}$ Logic gates, zener diode.

Passive Example

Resistor - It imparts electrical resistance
Helps to reduce current flow and regulate signals.

Capacitors - Stores electrical energy in electrical field $\rightarrow$ $\boxed{V_c = Q/c}$

Inductors - Stores energy in magnetic field when electricity flows.

PN-junction diode - used in small devices for current flow and one directional current.

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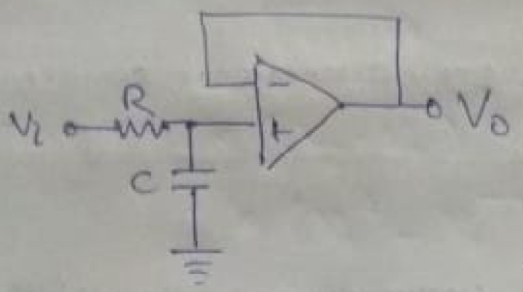
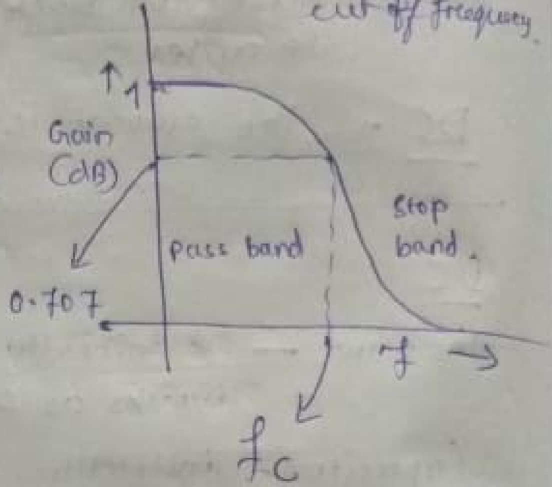
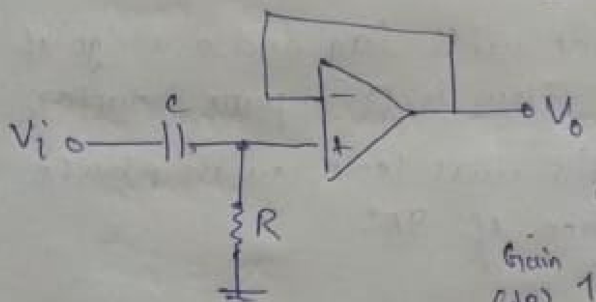
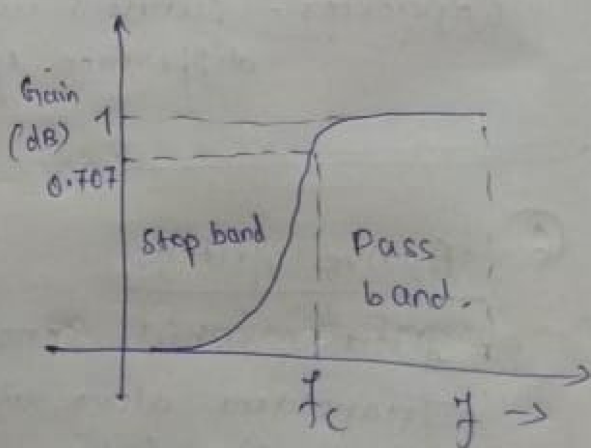
Low Pass Filters - constant output from 0 to cut off frequency.



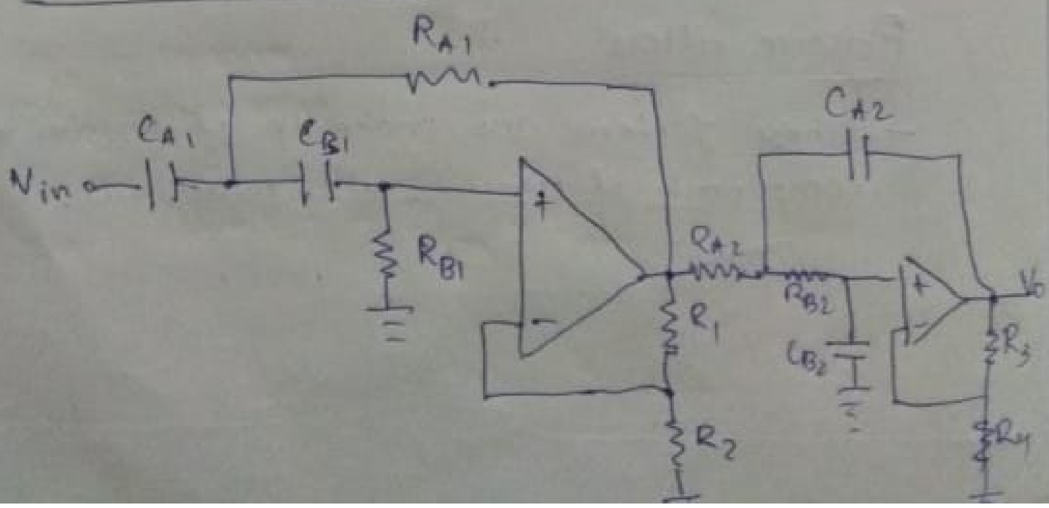


High Pass Filters - constant output above cut-off frequency.





Band Pass Filter



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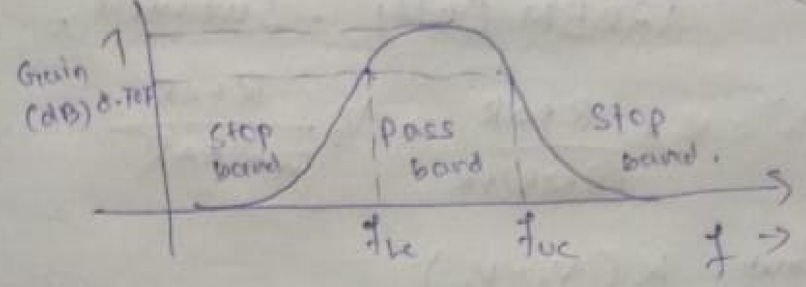
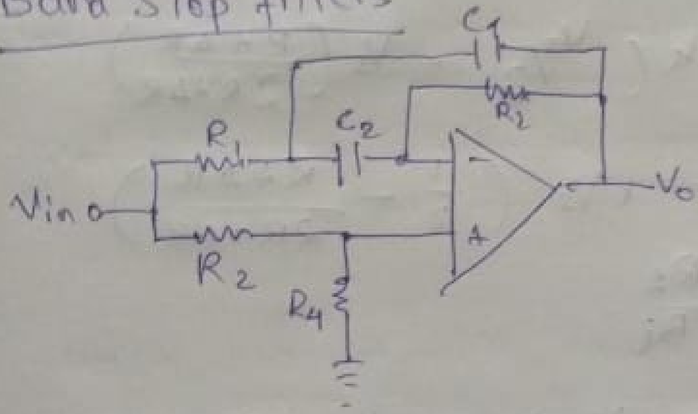
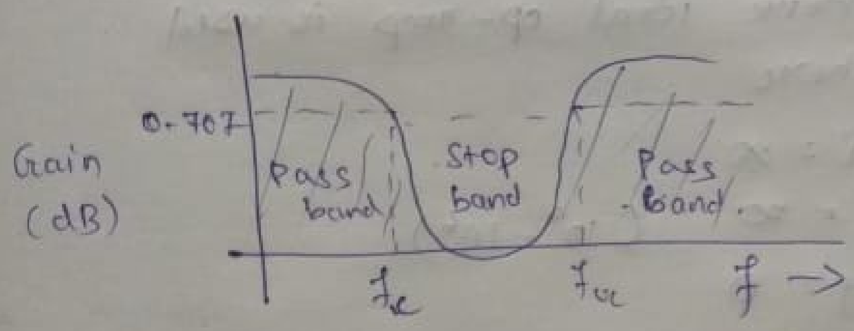


Band Stop filters





Transfer function — $\boxed{H(s) = \frac{Y(s)}{X(s)}}$

$$x(t) \rightarrow \boxed{h(t)} \rightarrow y(t)$$

Frequency Response → $\frac{V_{out}}{V_{in}} = \frac{X_c}{\sqrt{R^2 + X_c^2}}$

$\omega_c = \frac{1}{CR}$

$$\boxed{H(s) = \frac{\omega_0}{s+\omega_0}}$$

cutoff

$$\boxed{|H(j\omega_c)| = \frac{1}{\sqrt{2}} |H_{max}|}$$