PRECISION RECTIFIER
PG-III

In order to conduct, P-N junction diode minimum voltage of 0.6V is required. This indicates that input voltage less than 0.6V can not be rectified. But the voltage gain of the OPAMP is given by

$$A_v = \frac{v_o}{v_i}$$

∴ input voltage $v_i = \frac{v_o}{A_v}$

If $A_v = 1000$ then $v_i = \frac{0.6}{1000} = 0.7 \times 10^{-3}$ Volt.

i.e all input signals drawn to 0.6 mV can be rectified. Thus the means by which small input voltages is rectified is known as "precision rectifier". It has the characteristics of an ideal diode. The symbolic representation of the precision rectifier is shown in fig (1).

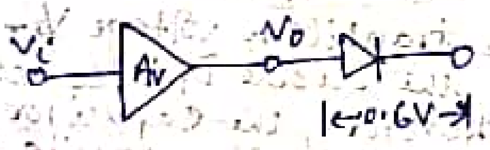


Fig (1)

Half wave precision Rectifier

There are three types of half wave precision rectifier

(1) Inverting positive polarity half wave precision rectifier (HWPR)
(2) Inverting Negative polarity HWPR
(3) Non-inverting Positive Polarity HWPR
(4) Non-inverting Negative " "

(I) Inverting positive polarity HWPR

This type of HWPR is shown in fig (2). There must be two cases i.e $v_i > 0$ & $v_i < 0$.

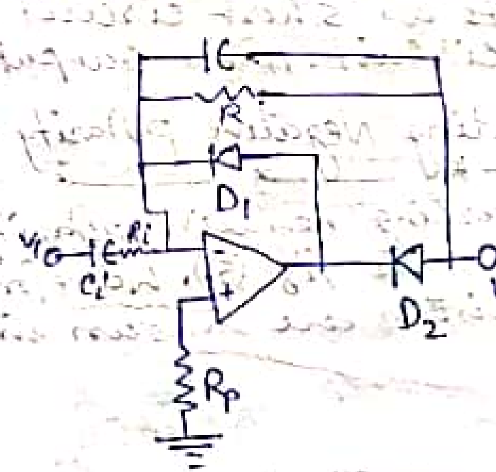


Fig (2)

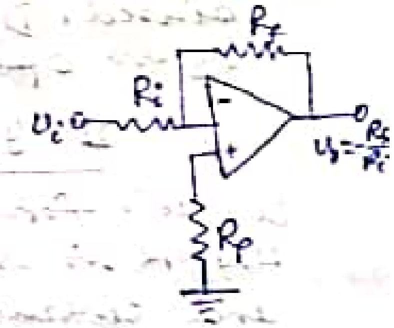


Fig (3)

When $v_i > 0$, diode D_1 is reversed biased, diode D_2 is forward biased. D_1 acts as open circuit and D_2 as short circuit. The equivalent circuit with D_2-ON and D_1-OFF is shown in fig (3). This is an inverting amplifier having output is $v_o = -\frac{R_f}{R_i} v_i$

As v_i is positive, output will be negative as shown in fig (4a)

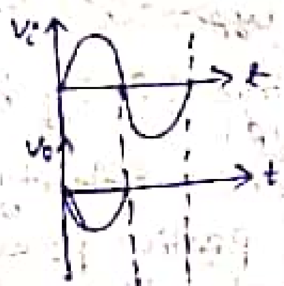


Fig: (4a)

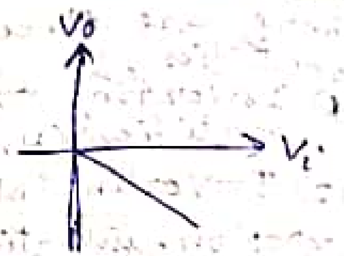


Fig (4b): Transfer charac.

When $v_i < 0$; diode D_1 is forward biased whereas diode D_2 is reverse biased. D_1 acts as short circuit & D_2 as open circuit. Hence output is zero.

II. Inverting Negative polarity HWPR

Circuit for inverting negative polarity HWPR is shown in fig (5). Waveforms and characteristics are shown in fig (6a) and (6b)

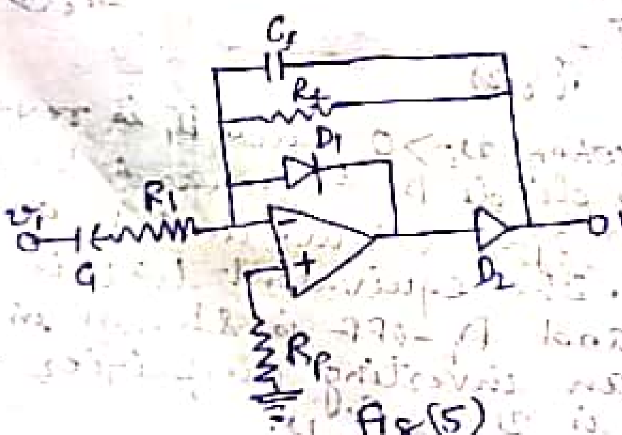


Fig (5)

Case (i) when $v_i > 0$, D_1 is forward biased, D_2 is reversed biased

Therefore output $v_o = 0$

Case (ii) when $v_i < 0$, D_1 is reversed biased, D_2 is forward biased

therefore output $v_o = -\frac{R_f}{R_i} v_i$

As v_i is negative in fig (6a), the output V_o is positive. This is shown in fig (6b)

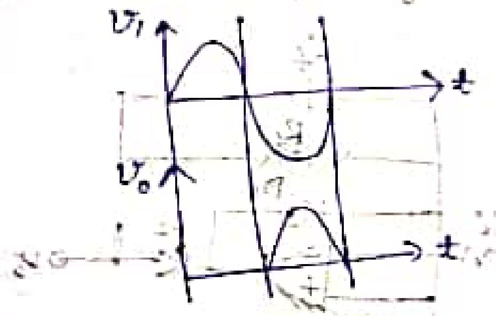


Fig (6a)

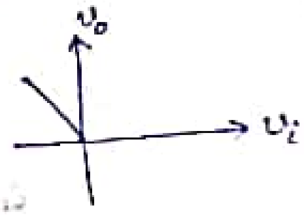


Fig (6b)

III Non-inverting positive polarity HWPR

A circuit for non-inverting positive polarity HWPR is shown in fig (7a, b). The waveform and characteristics are shown in fig (8a) and (8b) respectively.

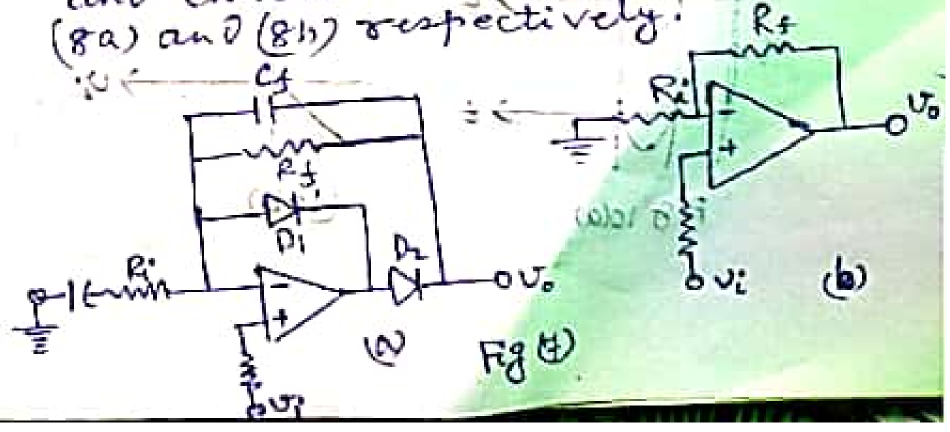
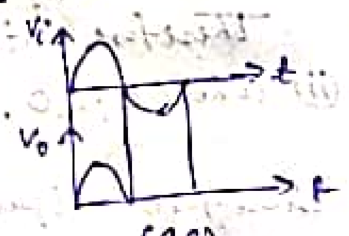
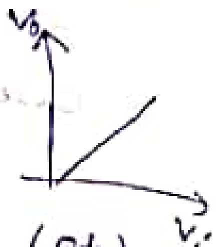


Fig (7)

IV Non-Inverting Negative Polarity HWPR:-



(8a)



(8b)

IV. Non-inverting Negative polarity HWPR:

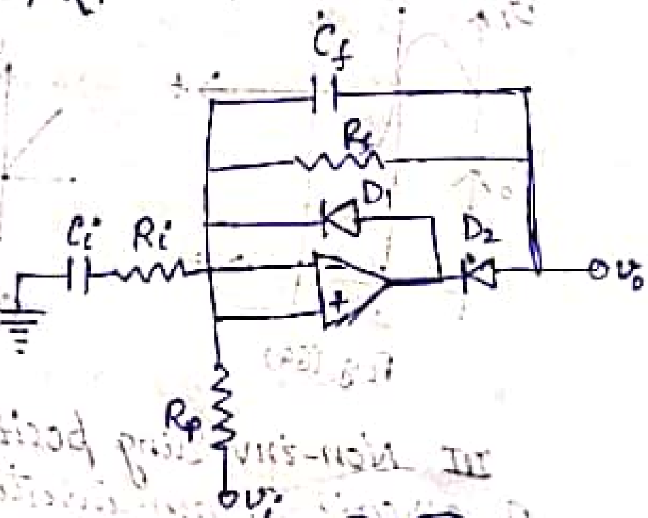


Fig (9)

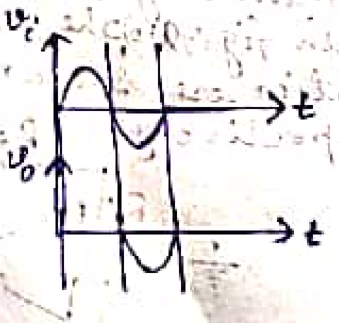
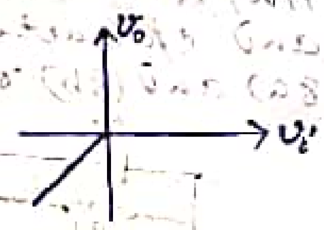


Fig 10(a)



(10b)

Circuit for non-inverting negative polarity HWPR is shown in fig (9). Wave-form and characteristic are shown in fig. 10(a) and 10(b).

Case (i) when $v_i > 0$, D_1 is forward biased, D_2 is reversed biased. Therefore output, $v_o = 0$

Case (ii) when $v_i < 0$ D_1 is reversed biased, D_2 is forward biased.

Therefore output $v_o = \left(1 + \frac{R_f}{R_i}\right) v_i$

As v_i is negative as shown in fig (10a) the output is negative.