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| **Course Name:** | **Linear Integrated Circuits and Design** | **Semester:** | **V** |
| **Date of Performance:** | **25/08/2021** | **Batch No:** | **B1** |
| **Faculty Name:** | **Prof. Milind Marathe** | **Roll No:** | **1912052** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **/25** |

**Experiment No: 2**

**Title: To implement Practical integrator & first order active low pass filter**

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| **Aim and Objective of the Experiment:** |
| * To implement Practical integrator & first order active low pass filter using opamp |

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| **COs to be achieved:** |
| **CO2:** Design circuits using op-amps as linear applications. |

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| **Theory:** |
| Integrator: In an integrator circuit, the output voltage is integral of the input signal. The output voltage of an integrator is given by  At low frequencies the gain becomes infinite, so the capacitor is fully charged and behaves like an open circuit. The gain of an integrator at low frequency can be limited by connecting a resistor in shunt with capacitor. |

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| **Circuit Diagram :** |
| **1. Practical integrator with sine wave input in time domain**    **2. Practical integrator with square wave input in time domain**    **3.** **Practical integrator with step input in time domain**    **4.** **Practical integrator as 1st order LPF** |

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| **Stepwise-Procedure:** |
| 1. Make the connections (schematic) as per the circuit diagram.  2. + Vcc and - Vcc supply is given to the power supply terminal of the Op-Amp IC.  3. By adjusting the amplitude and frequency, appropriate input voltage is applied to the inverting input terminal of the Op-Amp.  4. The output voltage is obtained after running the simulation.  5. Input and output voltage waveforms will be obtained. |

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| **Observation Table:** |
| |  |  |  |  | | --- | --- | --- | --- | | Sr.No. | Vin(Volts) | Vout p-p  (Theoretically)(Volts) | Vout p-p  (Simulated)(Volts) | | 1. | Sine Wave (2Vp-p) | 626mV | 625.37651mV | | 2. | Square wave (2 Vp-p) | 1V | 1V | | 3. | Step input (vi-1V) | -3V | -2.643521V | |

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| **Design calculation:**  Consider a lossy integrator circuit to integrate an input signal for the component values**.** Determine lower frequency limit of integration and study the response for the following inputs   1. Sine wave: If a sine wave of 1 V peak at 5000Hz is applied to the integrator, draw its output waveform. 2. Square wave: If a square wave of 1 V peak at 5000Hz is applied to the integrator, draw its output waveform. 3. Step input: If a input is a step voltage of Vi=1 V for 0 is applied to the integrator, then the output voltage at is   Given :  We know the frequency at which the gain is 0 dB,  --------(1)   1. For sine wave   Given and , the input voltage is  We know  Hence  =   1. For square wave 2. For step input |

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| **Waveforms:** |
| **1. Output waveforms for a practical integrator with sine wave input in time domain**        **2. Output waveforms for a practical integrator with square wave input in time domain**        **3. Output waveforms for a practical integrator with step input in time domain**        **4. Integrator as a first order low pass active filter** |

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| **Post Lab Questions:** |
| 1. Explain the difference between integrator and differentiator, give an application of each?  |  |  | | --- | --- | | Differentiator | Integrator | | In an op-amp differentiator circuit, the output | In most of the operational amplifier circuits, | | voltage is directly proportional to the input | the feedback connection which is used is | | voltage rate of change with respect to time, | because of resistive in nature by a straight | | which means that a quick change of the input | resistive line outlining as a minimum portion | | voltage signal, then the high o/p voltage will | of the network. But for the op-amp integrator, | | change in response. As the output of an op- | the feedback will be provided by the capacitor | | amp differentiator circuit is proportional to the | among the input and output of the operational | | change in input. When the inputs of the | amplifier. | | differentiator circuit are standard waveforms |  | | like sine, square, triangular then the output |  | | waveforms will be very different. |  | |  |  | | Vout = – Rf C dVin/dt | Vout = −∫Vin/R C dt +c | |  |  | | Differentiating amplifiers are most | The integrator circuit is mostly used in analog | | commonly designed to operate on triangular | computer, analog to digital converter and | | and rectangular signals. Differentiators also | wave-shaping circuits. A common wave- | | find application as wave shaping circuits, to | shaping use is as a charge amplifier and they | | detect high frequency components in the | are usually constructed using an operational | | input signal. | amplifier though they can use high gain | |  | discrete transistor configurations. |   2)Explain why integrators are preferred over differentiator in analog computers?  A *differentiator* circuit produces a constant output voltage for a steadily changing input voltage. An *integrator* circuit produces a steadily changing output voltage for a constant input voltage. Both types of devices are easily constructed, using reactive components (usually capacitors rather than inductors) in the feedback part of the circuit. Integrators are more linear than the differentiators and the integrators reduce the power consumption than the high pass filter. Integrators provide linear signal than the differentiators & also reduces power consumption than the high pass filter. The ability to integrate a given signal provides the differential equations & therefore provides the ability to electrically solve analog of physical system operation.   1. Record the pass band gain and cut-off frequency for 1st order HPF. What is the difference between passive and active filter.      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | Basic Comparison |  | Active Filter | | | Passive Filter | |  |  |  | |  | Definition | Active filters are those filter | | | | Passive filters are the filter | | | |  | |  |  | circuits | that | are | designed | circuits that are formed using | | | |  | |  |  | using transistor and op-amp | | | | only resistor, | inductor | | and |  | |  |  | as their basic components. | | | | capacitor as | their | major | |  | |  |  | Along | with | these | elements | components. | As |  | no |  | |  |  | circuits of active filters also | | | | amplifying | element | | is |  | |  |  | contain | resistor | | and | present in it thus passive | | | |  | |  |  | capacitor, but not inductors. | | | | filters offer low signal gain. | | | |  | |  | Q Factor | High |  |  |  | Very low |  |  |  |  | |  | Circuit Complexity | More Complex | | |  | Less Complex | than | Active | |  | |  |  |  |  |  |  | Filter |  |  |  |  | |  | External Power Supplied | Required | |  |  | Not Required |  |  |  |  |   4)State the condition for proper integration of input signal?    5)What are the limitations of an ideal integrator?  The ideal integrator suffers from two main limitations. One comes from the fact that the output voltage of the opamp can not exceed the supply voltage. The output of the integrator is inversely proportional to the time constant *τ* = *RsCf*. The larger the time constant *τ*, the longer it takes to saturate the integrator. The second limitation is a consequence of the *offset voltage* present even for zero input. It may be only a few millivolts, but it it gets integrated over time it eventually drives the OpAmp output to saturation. To prevent this from occurring, a large (1-10 MΩ) resistor *Rx* is added in parallel with the capacitor |
| **Conclusion:** |
| We studied the Practical Differentiator & first order active high pass filter using op-amp. The theoretical and practical value is almost same. |

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| **Signature of faculty in-charge with Date:** |