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Designing a Media of Active Learning for Teaching the Passive High Pass Filter (PHPF) by developing its Bode Plot by using Excel Humuntal Rumapea<sup>1</sup> Dahlan Sitompul<sup>2</sup> Darwis Robinson Manalu<sup>3</sup> 1 Universitas Methodist Indonesia. Abstract In this paper, the writer developed active learning media that is used in class that has implemented an active learning strategy in the class, and especially for developing nation student help them in addressing their hindrances in mastering the technology due to the lack of budget and facility to run the conventional way of teaching and learning, especially in this era of Covid 19 Pandemic that has forced us to do virtual learning to inhibit the widespread of the deadly virus; this media will be helpful.

This media will help the teacher to develop his/her teaching planning and strategy and help the student in understanding the attributes or the properties of the PHPF easily by observing the Excel table of the PHPF variables values and the Bode Plot of the PHPF instead of calculating each of the variable values of the PHPF manually; the student can not observe and see the big picture of the PHPF characteristics promptly and will not enable them to understand it immediately.

This media was developed by using two wellknown application programs, Excel and ISIS Proteus. The Excel shows the Bode Plot of the PHPF using the table variables values of the PHPF (frequency of the input, the Gain of the PHPF in Decibel-dB, and the Phase Angle between the output voltage ( $V_o$ ) of the circuits and the input voltage ( $V_{in}$ ) put into the PHPF input port) and the ISIS Proteus will be used to prove the values shown on the excel table and the Bode Plot shown by excel; ISIS Proteus is a specially purposed simulator to simulate Electrical, Computer, Electronics, Microcontroller, Microprocessor, and control devices working principle and their properties. Developed media of teaching has successfully shown the attributes of PHPF.

Keywords: Proteus ISIS; High Pass Filter; Bode Plot; Active Learning; Excel; Media of Teaching

**INTRODUCTION** The filter is one of the fundamental elements of signal processing and is widely used in many electronic devices. Based on the components used in the designing of the filter, the filter can be classified into two types, Active Filter (the use of active components such as OP-Amp, and Transistor beside the filter main components it's self such as Resistor, Capacitor, and Inductor), and Passive Filter (the used of resistor, Capacitor, and Inductor in its design).

As mentioned before in the Active Filter, the Operational Amplifier (the Op-Amp ) is used to amplify the output signal of a filter to be processed further. Based on the type of the required signal frequency to be passed to the output of the filter, the filter can be divided into two types of filters as follows, the High Pass Filter, and the Low Pass Filter.

A combination of the two filters mentioned above (HPF and LPF) result in the third and the fourth types of filter can be built; the Band Pass Filter-BPF, and Band Stop Filter-BSF. To make the output of the filter close enough to the output of an ideal filter, a high-order type of filter can be used. The higher the order of the filter (by cascading the first order of the filter to form the higher order of the filter) the better the output of the filter, but as the consequence, the math equation of the filter will be more complex and of course it will be more expensive.

In this paper, we will discuss only the first type of filter, the Passive High Pass Filter (PHPF); First Order High Pass Filter. Some engineers and scientists call the filter a transfer function and are widely mentioned in Control System Engineering. Understanding the characteristics of a filter is a prerequisite for an Engineer to design complex electronic devices.

Due to the importance of understanding how the filter works and as an effort to help the student in answering the worksheet on signal filter provided by some organization[1], the author develops an active learning media in teaching this subject. This application will enable the teacher to run the class conveniently and the student can understand the subject easily and can use it to design their own first order PHPF conveniently. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 16, Number 8 (2021) pp. 645-650 © Research India Publications.

<http://www.ripublication.com> 646 RELATED WORK Many scholars and researchers have developed a lot of kinds of media of active learning and teaching by using computer programming or not in the form of simulation.

Some of the published papers in this field are as follows, in this paper [2] the author reported the design of a decoder to display the result of the digital voltage level on a seven-segment display in the form of characters "H" and "L". The author proposed the use of his design is implemented in active learning classes especially in the electronic digital laboratory.

In paper [3] the authors develop an active learning simulator using both MCU8051 IDE and (Small Devices C Compiler-SDCC). In this paper, the author reported that the simulator will display the level voltage of a pin of an 8051 port on a virtual seven-segment display and propose to use it as a media of teaching especially in the classes that have adopted active learning strategies.

In this paper [4] the authors reported the development of a simulator that simulates the process of multiple interrupts runs on an 8051 microcontroller by using MCU8051 IDE and ASEM 51 [4]. In this paper the author developed a media of active learning and teaching in the microcontroller field and programming it in C language (SDCC) by using structs and pointer in retrieving the character stored in IRAM of the microcontroller to be displayed on a virtual LED.

In this paper [6] the author developed a teaching media for ALFHIE class, that simulates the interfacing of MCS-51 to a 4 X 4 Keypad and displays the character input from the Keypad onto two different displays, the program run on ASM-51. In this paper [7] the author develops a simulation for ALFHIE class. This simulation program was developed by using SDCC to simulate how to read the Busy Flag of the LCD and proposed it rather than using a delay time that is hard to compute it and each and every LCD has its own delay time.

**Proposed System** In this paper, the author proposed the development of an active learning media of the First Order Passive High Pass Filter. The media is the form of a simulators and was developed by using two famous application Excel and ISIS Proteus. It can be used the teacher or lecturer to teach students of the Filter characteristic or attributes and the student can use it by themselves and change the values of the filter variables (frequency of the input signal, the Capacitor, and Resistor variables).

As mentioned above the Excel will display the Bode plot of the filter based on the value of the filter variables input namely Signal frequency, Resistor, and Capacitor values to the excel table. The teacher may ask the student to observe the Bode Plot of the filters and compare the Bode Plot's result to the theory taught by the teachers or the lecturers.

The teaching participants can also compare the result shown on the Bode Plot to the

result obtained by the Proteus. Output of the Excel and the ISIS Proteus (Simulation of a particular output gain and Phase Angle between the output voltage and input voltage of a specific value of the Filter Frequency).

After running the simulation student can ponder in their heart and mind the three results obtained from the theory given by the Lecturer or the teacher, from the Bode Plot shown by the Excel, and from the result obtained by the ISIS Proteus as well; they should be in accord. Simulation In this simulation, the author simulated a PHPF frequency response with Resistor values and Capacitor values 20 K $\Omega$ , 1.5nF respectively; the student can change these two variables in their future simulation and analysis as their wish.

The cutoff frequencies, Gain in dB, and the Phase angle, 5305 Hz, -3dB (0.707), 45 degrees respectively[12]. Figure 1 below shows the diagram of the PHPF Fig. 1: The Diagram of PHPF[13] It can be seen from the diagram that the output voltage is measured across the resistor. We can apply the voltage divider equation to find the output voltage[14].

The equation for the gain of a PHPF is as follows[12][15],  $= \frac{1}{\sqrt{1 + (f/f_c)^2}}$  The cutoff frequency for the PHPF is  $f_c = \frac{1}{2\pi RC}$  [12][15] And the gain of the PHPF at the cutoff frequency is 0.707 ( $1/\sqrt{2}$ ) or -3 dB[15][12] The phase shift equation for PHPF [12] is  $\phi = -\tan^{-1}(f/f_c)$  By using the mentioned above equations Gain in dB ( $20 \log V_o/V_{in}$ ) [15],  $f_c$ , and Phase Shift ( $\phi$ ) and putting the values of the PHPF components (R and C) and the variable frequency of the input signal into the Excel as shown in figure 1 below, we can observe the result of the simulation; the result of the simulation has been captured and shown in Fig. 2, Fig. 3, and Fig. 4. Fig.

2 shows the table of PHPF variables values; the input signal frequency, the gain in dB, and the Phase Angle in degree. Fig. 3 shows the Bode Plot of the filter as the result of International Journal of Applied Engineering Research ISSN 0973-4562 Volume 16, Number 8 (2021) pp. 645-650 © Research India Publications. <http://www.ripublication.com> 647 the simulation. Fig. 4 (Fig. 4.1-Fig. 4.4) shows the result of the ISIS Proteus Simulation.

Fig. 2: The Table of PHPF Variables International Journal of Applied Engineering Research ISSN 0973-4562 Volume 16, Number 8 (2021) pp. 645-650 © Research India Publications. <http://www.ripublication.com> 648 Fig. 3: The Bode Plot of PHPF[11] Fig. 4.1: The result of the ISIS Proteus Simulation; the PHPF circuits. From Fig. 4.1

it can be seen clearly that for an input of a sinusoidal signal with an amplitude of 10 V

(AC), a 7.07 V (AC) voltage will be read by the AC voltmeter;  $V_{AC} = V_P / (2^{0.5})$  and the output voltage at the Cutoff Frequency will be read as a 5.03 V;  $0.707 \times V_{in} = 0.707 \times 7.07$  V. Fig. 4.2: The result of the ISIS Proteus Simulation; The Phase Angle at the Cutoff Frequency Fig. 4.2

shows the Phase Angle of 45°; the input signal lagging the output signal (the output signal leading the input signal) by 45° at the cutoff frequency; at 5305 Hz (5.305 KHz)[16][17]. Fig. 4.3: The Circuit simulation of PHPF to obtain the Bode Plot of Fig. 4[18] Fig. 4.4: The result of the ISIS Proteus Simulation; Bode Plot obtained from the ISIS Proteus simulation[18] From Fig. 4.4

we can see that the cutoff frequency of the PHPF is 5.3 KHz; the gain is -3 dB. The Flow Chart of the program The flow chart below shows the taken steps to input the variables of the PHPF into the Excel table and run it and compare the obtained result to the obtained result by ISIS Proteus; the Gain (in dB), Phase Angle in degree, and the cutoff frequency in Hz [19] [20][21].

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<http://www.ripublication.com> 649 Fig. 5: The flow chart of the Bode Plot simulation development CONCLUSION From the result of the simulation of the excel, and the comparison of the excel Bode Plot simulation to the result of the ISIS Proteus Simulation some things can be observed and some conclusions can be made, 1.

Excel can be used to simulate the attributes or characteristics of the Passive High Pass Filter-PHPF 2. The result of the excel (Gain in dB, The Phase Angle) in accordance with the standard theory of Passive High Pass Filter 3. The Result of the ISIS Proteus Simulation of the Gain in dB, the Phase Angle are in accordance with both the result of the Excel and the standard theory of Passive High Pass Filter 4. The Excel can show the trend of the gain (in dB) and the Phase angle (in Degree) or in Radian 5.

The teaching participants (Teacher/Lecturer and the Students) can use the simulator to study and pondering the attributes of the Filter by his/herself. Closing This paper hopefully can contribute to Science especially in the field of filter designing and control. This simulation can be used to teach the student in advance of this topic (Passive High Pass Filter) conveniently by the lecturer/teacher in their classes, or by the Instructor in a vocational training center before doing the real laboratory work or experimentation; to cut the budget to buy the devices for underdeveloped countries.

It can also be used widely in the classes that have adopted Active Learning Strategy,

especially in countries that have implemented the teaching strategy of Active Learning For Higher Education (ALFHE), and the Low and middle-income countries, especially those who do not have the capability or budget to buy or to provide the devices to be used by their students.

Hopefully, this paper will enable the teaching participants (the teacher/Lecturer or instructor) to run the teaching and learning process comfortably, conveniently, and happily in the Covid- 19 Pandemic era.

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