Active Learning Laboratory on Antenna and Microwave Filter Design for Microwave Engineering Course in Technological University (DAWEI)

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***Abstract*-This research aims to develop a microwave filter and antenna laboratories and introduce active learning teaching style for a microwave engineering course in Technological University TU (DAWEI), Myanmar. This laboratory includes two parts: antenna and filter laboratories. Each laboratory includes a student laboratory paper. In the student laboratory paper, the summarized theory, important calculation steps and designed problem are included. Also, learning processes of student consist of a calculation, fabrication and finally measurement. Moreover, a low-cost experimental set to be used in laboratories as a teaching aid. Both experimental set are designed to operate at 1.2 GHz to 2.9 GHz and displayed with Graphical User Interface (GUI). The cost of our filter and antenna experimental set are around 9000 Baht. The proposed laboratory was evaluated by 3 experts. The student testing groups consisted of 3 groups with 3 students in each group. The results revealed that the average score of students are 4.80 points (total of 5 points). As a result, it can be conducted that the developed filter and antenna laboratory can be used effectively and provides theoretical knowledge and the practical skill to student.**

Keywords—Active learning, Experimental set, Microwave filter and Antenna

I. INTRODUCTION

In TU (DAWEI), teaching and learning of Microwave Engineering course mostly has been used the classroom with a traditional teaching style. The traditional teaching style is focused on lecturer's teaching instead of student active learning without practical. In 2016, new curriculum has developed not only theory but also practical [1]. Thus, laboratory course is needed to fulfill the microwave course. Moreover, laboratory equipment is required in practical part. The experimental equipment in TU (DAWEI) is insufficient to cover with a practical of students. The limitation of budget [2] and teaching with active learning style in the classroom is a challenge in development. And also, standard commercial equipment is very expensive. Teachers cannot individually effort such devices for the practical laboratory purpose [3]. Thus, we have to construct our own experimental set with a very low cost and acceptable performance [4]. The proposed laboratory includes two parts: antenna and filter laboratories. Each laboratory involves instructor lecture, student activities, laboratory paper the proposed low-cost measurement equipment and tested measuring result. In this research, we focused on the implementation of an active learning laboratory for engineering students at Technological University (DAWEI), Myanmar. The objective of this research is to construct low cost experimental set for microwave filter and antenna laboratory and laboratory course in order to improve the effectiveness with active learning.

II. ACTIVE LEARNING

Active learning generally defined as any instructional method engages students in the learning process. M. prince [5] conducted that the active learning requires students to do meaningful learning activities and thinks about what they are doing. While this definition could include traditional activities that are introduced in class room and added more student's activity. Effectiveness of the active learning teaching style is

1. To complete not only theoretical but also practical skill.

2. To build in further knowledge in their life.

Active learning is not completely effective for engineering teaching because of many limitations such as budge [6] and educational tools. Nevertheless, the student activities can be improved in engineering teaching with active learning style [7].

III. RESEARCH METHODOLOGY

The objectives, details and outcome of microwave and antenna courses were investigated. It is found that the microwave filter and antenna are very important. Thus, the microwave filter and antenna laboratories are chosen to be the first example of laboratory course. The summarized theories of microwave filter design and antenna design are illustrated. The AWR simulation

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program is employed to confirm the calculation. An experimental set is constructed. Finally, student testing group will be employed to test the experimental set.

A. AWR software Simulation

AWR simulation free software [8] is used to conduct the objectives of the microwave filters and patch antenna laboratories. Firstly, problem was calculated by using theoretical knowledge from classroom teaching. Next, the simulation is used to create the fabricated model in Figure. 1. Then, the fabricated filter on Flame Retardant 4 (FR4) substrate by using printed circuit board (PCB) is performed. And also, Figure. 2 show EM simulation of radiation pattern of antenna laboratory. The frequency of student's fabricated antenna model meets at 2.68 GHz. The specified cut-off frequency of low-pass filter results is 1.5 GHz as shown the simulation results in Figure. 3.

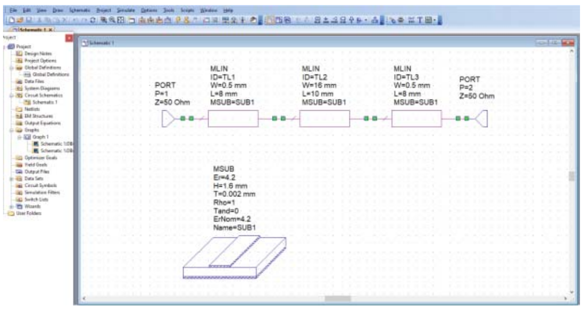


Figure.1. Microstrip low pass filter simulation.

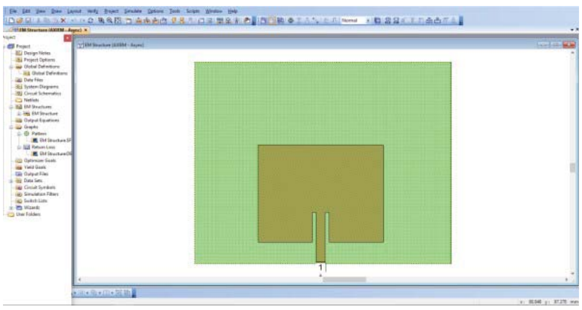
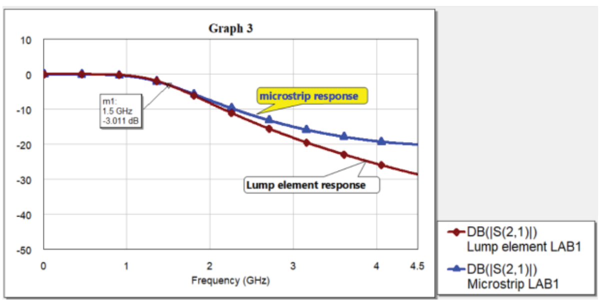


Figure.2. EM simulation of patch antenna



Figiure.3. Frequency response of low pass filter.

B. Filter laboratory design

1). Filter measuring experimental set design

The block diagram of filter experimental set present in Figure. 4. The experimental set consists of transmitter, Filter, Device Under Test (DUT), power detector, Arduino microcontroller and GUI display. The 1.2-2.9 GHz microwave signal source is connected to the DUT. The RF signal from the DUT was detected into 0.4-8 GHz frequency range in the power detector and microcontroller used this digital signal. The output of Arduino microcontroller is connected to MATLAB GUI for display results.

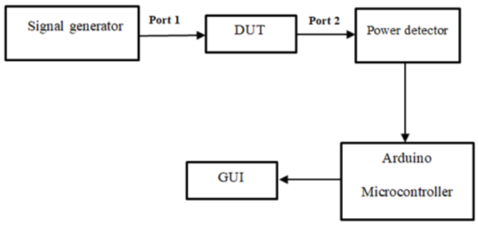


Figure.4. Block diagram of filter measurement experimental set

2). Designing equation for filter laboratory

The cut off frequency of a filter is controlled by varying the impedance of microstrip line. The length and width of microstrip line for low pass filter [9] are given by equation (1) and (2).

$$L_c = \frac{cZ_L}{\omega_0 R_0 \sqrt{\varepsilon_{effc}}} \qquad (1)$$

$$L_L = \frac{cR_0}{\omega_0 Z_H \sqrt{\varepsilon_{effL}}} \qquad (2)$$

$$\frac{W}{d} = \frac{e^A}{e^{2A} - 2} \qquad (3)$$

C. Antenna laboratory design

1). Antenna measuring experimental set design

The antenna laboratory demonstrates the role of the antenna in a complete microwave system, which includes a transmitter unit, receiver unit, power supply unit, turntable antenna supporter, MATLAB GUI and displayed PC unit shown in Figure. 5. The rectangular horn antenna with microwave signal source is used as a transmitter. The VCO converts the output signal from the receiving antenna to digital signal and it depends on position of

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patch antenna. The turntable equipment of the antenna laboratory is designed to measure the radiation pattern of fabricated antenna. The movement of turntable and data acquisition is controlled by microcontroller. The MCU is connected to a computer running measurement software on MATLAB and observes antenna radiation pattern on GUI display.

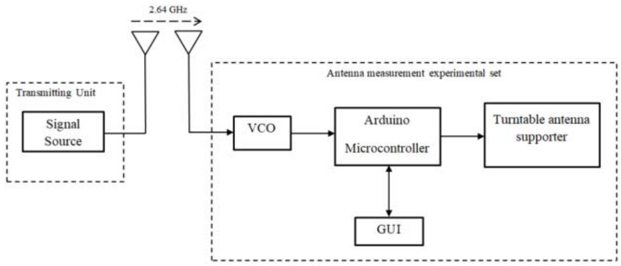

Figure.5. Block diagram of antenna radiation pattern measurement experimental set.

2). Designing equation for filter laboratory

The effective length of patch antenna is equal to the one half of a wave length within the dielectric medium. The Electric fields at the edges of the patch undergo fringing effects. As a result of these effects, effective length of the patch antenna appears to be greater than its actual length [10]. So, actual length of the patch antenna is usually considered as L< λ/2. Actual length and effective length of a patch antenna can be related as equation (3).

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (4)$$

$$L = L_{eff} - 2\Delta L \quad (5)$$

Width of the patch antenna is calculated by using in equation (4).

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (6)$$

IV. RESEARCH RESULTS

This research results are obtained from the four parts of research work.

A. The developed experimental set

The experimental set was developed using assigned behavioral objectives of filter and antenna laboratory. The experimental set consists of measurement of cut-off frequency of filters and radiation pattern of fabricated antenna. Figure.6, 7 and 8 presented the constructed result of the experimental sets, the frequency oscillator can be swept between 1.2-2.9 GHz, the measured results of fabricated filters and antenna was covered with theory behavior. Interesting features of the developed experimental set were low cost, compact design, ease of maintain and fast measuring time.

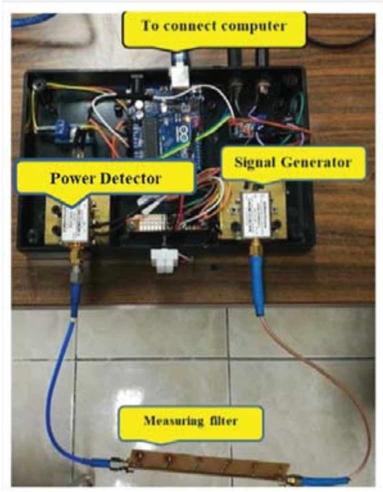

Figure.6. Internal construction of filter experimental set.

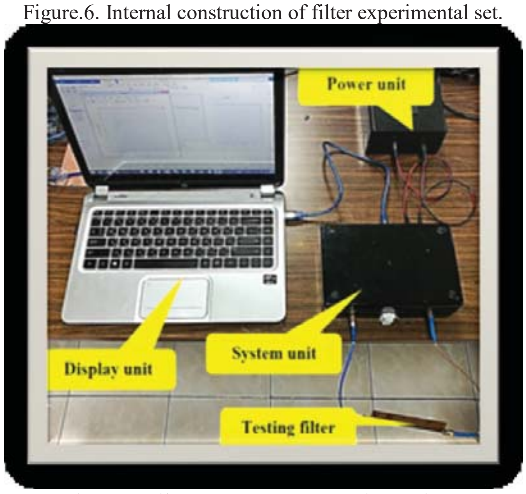

Figure.7. Filter measurement experimental set.

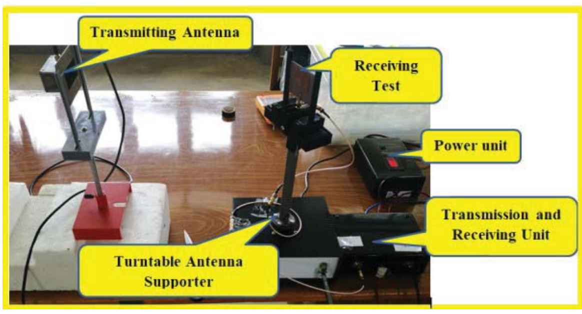

Figure.8. Antenna measurement experimental set

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B. Students' result achievement from doing laboratory

This part of result obtained from calculation new designed problem. It was found that most of the student can apply the theoretical concept to practical skill. After teaching and learning process, students can create the new circuit of antenna and filter by each group as shown in Figure. 9. And also, Figure. 10 represent the measured frequency response of low pass filter obtained from each group of students. The results meet at 1.5 GHz cut off frequency in low pass filter laboratory. Figure.11 represents the measured result of radiation pattern and beam-widths were approximately 60 degrees.

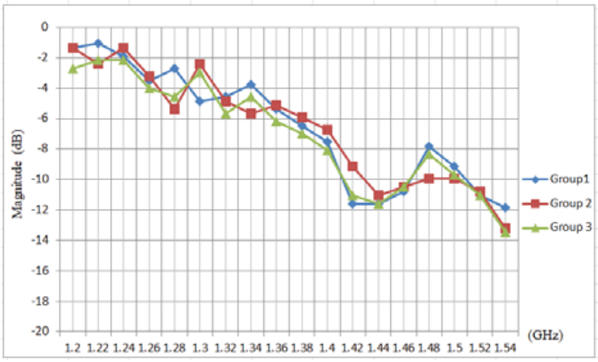
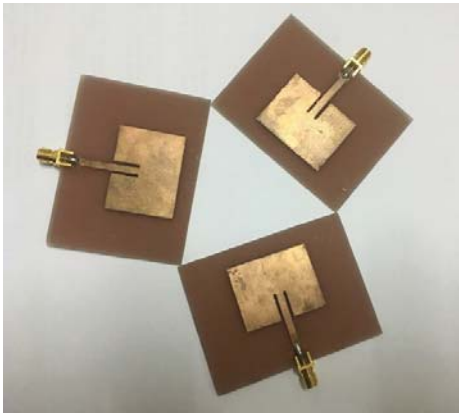


Figure.10. Frequency response of low pass filter



(a)

(b)

Figure.9. Fabricated result of students (a) low pass filter at 1.5 GHz cutoff frequency, (b) patch antenna at 2.68 GHz

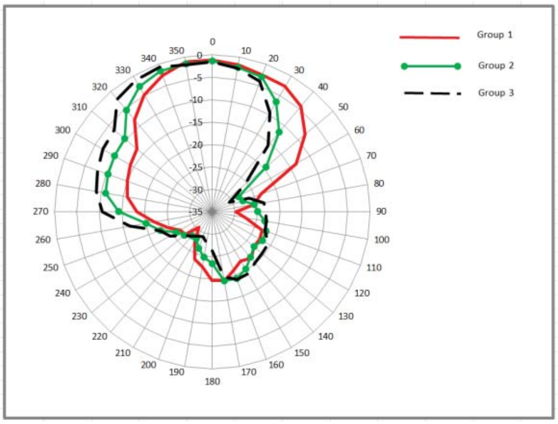


Figure.11. Radiation pattern of patch antenna

C. The result of student's satisfaction on teaching

The developed experimental set was implemented by using with 3 groups of fifth year electronics student of Technological University (DAWEI), Myanmar as shown in Figure. 12. The student result showed Figure. 13. The results found that the average score of students are 4.80 points (total of 5 points). As a result, the developed laboratory course can be effective with theoretical knowledge and the practical skill to student. The following questions are used in student's evaluation process.

1. The teacher voice hears clearly.
2. Layout of experimental set.
3. AWR software is easy to use for student.
4. Steps and detail in lab sheet.
5. The experiment set can see measuring data clearly.
6. The experimental set easy to use.
7. The experimental set is safety for student.
8. Timing for lab experiment.
9. Impression for using.
10. The teaching knowledge can useful for future work.

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Figure.12. Demonstration with student groups.

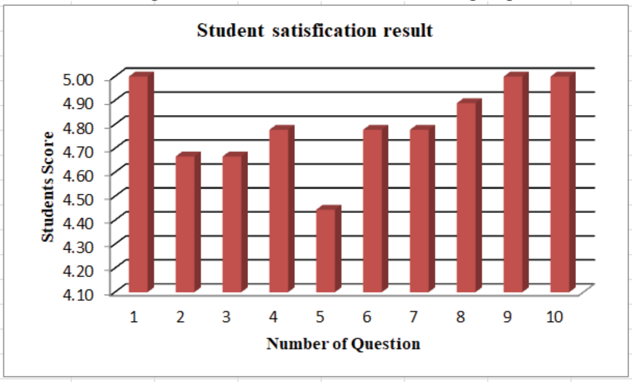

Figure.13. Evaluated results of student satisfaction.

D. The quality of experimental set

The quality of experimental set of filter and antenna laboratory course was evaluated by 3 experts who have been teaching in electronics and telecommunication engineering. The evaluated result from experts had shown in Figure. 14, illustrated that the mean level of laboratory course is 4.20 from a maximum of 5 point. As a result, the developed experimental is very effective for microwave filter and antenna laboratory course. The following questions are used in expert's evaluation process.

1. Usability
2. Functionality
3. Performance

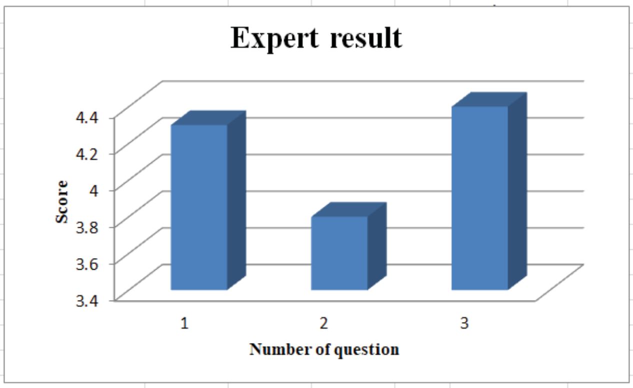

Figure.14. Evaluated results on teaching experimental set

V. CONCLUSION

This research presents the development of microwave filter and antenna design laboratory on microwave course for Technological University (DAWEI). Active learning teaching style encourages the students to receive theoretical and practical knowledge. This laboratory includes two parts: antenna and filter laboratories. Each laboratory includes a student laboratory paper, designed problem and the developed low-cost measurement equipment. In the student laboratory paper, the summarized theory, important calculation steps and designed problem are included. Also, learning processes of student consist of a calculation, fabrication and finally measurement. After developing on microwave filter and antenna engineering course, the research results found that the developed experimental sets were high usability, functionality and good performance to be efficiently in the engineering teaching. After learning and teaching process, student can apply their knowledge in their future work professionally.

VI. ACKNOWLEDGMENT

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Biography

May Sandar Moe graduated with the degree of Engineering (Electronics)
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