Readability of Amplitude Modulation (AM) Transmitter and Receiver Laboratory Manual

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Abstract **–This research paper investigates about the readability of Amplitude Modulation Transmitter and Receiver Lab Manual. Recent research has indicated that the lack of procedure, the structure of the manual lab and the complexity of the words or phrase used in the manual are the main factor UiTM Engineering students are not capable of fully comprehending this lab manual. This research used three (3) readability software such as, Flesch Reading Ease, Flesch-Kincaid Grade Level and Gunning Fog Index. The Flesch Reading Ease factor was identified as 69.5 while the Flesch Kincaid Grade Level was determined at 5.8. In addition, the Gunning Fog Index test result yields a score of 8.1. These results indicate that the lab manual should be easily read and understood by 12 years old American student. During the research, changes were made to improve the readability factor. Further analysis of the lab manual, the readability test result indicates that the readability of the Flesch Reading Ease factor was identified as 63 while the Flesch Kincaid Grade Level was determined at 7.4 and the Gunning Fog Index test result yields a score of 10.4. Even though the readability factor has generally increased, the changes made were deemed necessary.**

Keywords – AM Transmitter and Receiver, Readability, Lab Manual.

I. INTRODUCTION

AM TRANSMITTER

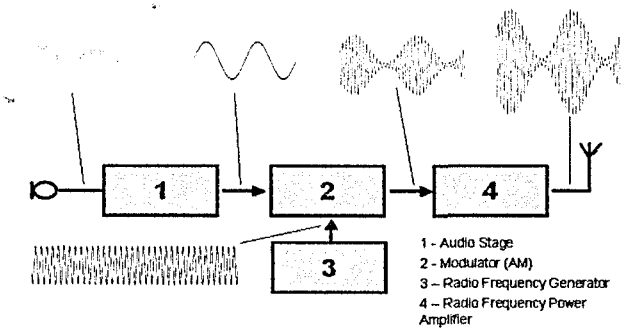

Figure 1. AM transmitter block diagram

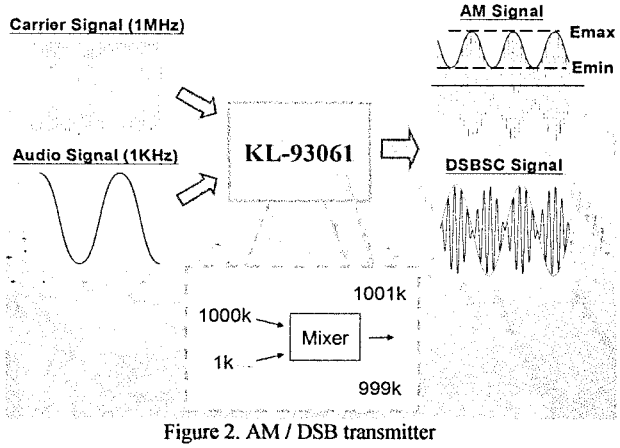

Figure 2. AM / DSB transmitter

Amplitude Modulation (AM) is a form of modulation where the amplitude of the carrier wave varies in direct proportion to that of a modulating signal. AM is a relatively inexpensive, low quality form of modulation that is used to broadcast commercial radio, most commonly for transmitting information via a radio carrier wave.

Modulator is non-linear devices with two inputs and one output where one input is a single, high frequency carrier signal of constant amplitude and the second input is conversational. In the transmitter, the sine wave doesn't contain any information. The sine wave needs to be modulated in some way to encode information on it. There are three common ways to modulate a sine wave and one of them is Amplitude Modulation. Both the picture part of a TV signal and AM radio stations use amplitude modulation to encode information. In amplitude modulation the amplitude of the sine wave varies from its peak-to-peak voltage changes. So, for example, the sine wave produced by a person's voice is overlaid onto the transmitter's sine wave to vary its amplitude. It can be transmitting the information once finish modulates a sine wave with information.

AM double sideband full carrier (DSBFC) is one of the types of amplitude modulation and most commonly used. The relationship between the carrier, the modulation signal and the modulated wave were illustrated in Figure 1.1. The figure shows how an AM waveform produced when a single frequency modulated signal acts on high frequency carrier signal. The output waveform contains all the frequency that makes up the

AM signal and is used to transport the information through the system. The shape of modulated wave is called AM envelope. It can be said that with no modulating signal, the output waveform is simply the carrier signal. However, when a modulating signal is applied, the amplitude of the output wave varies in accordance with the modulating signal. Note that the repetition rate of the envelope is equal to the frequency of the modulating signal and that the shape of the envelope is identical to the shape of the modulating signal. [1]

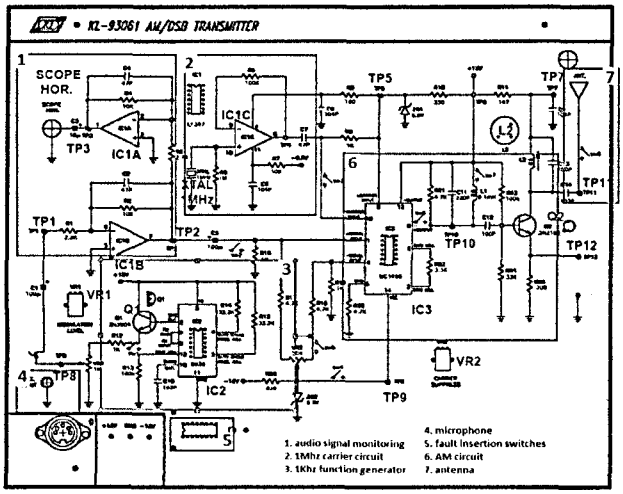

Figure 3. AMIDS13 transmitter module KL-93061

IC1 generates an about 1 kHz Sine wave and buffered by transistor Q1.If an external signal source is inserted into the MIC INPUT, the sine wave from IC1 will be disconnected. IC1B amplifies the input signal (output at TP2) and the gain is adjusted by VR1.IC1A amplifies the signal at TP2 and output at SCOPE HOR for input signal monitoring for the better view of trapezoid pattern. IC3 is an AM modulator modulating Audio Signal from TP2 and 1 MHz Carrier Signal amplified from IC1C.Q2 is a RF power amplifier to amplify the modulated signal at 1 MHz. [2]

AM Receiver.

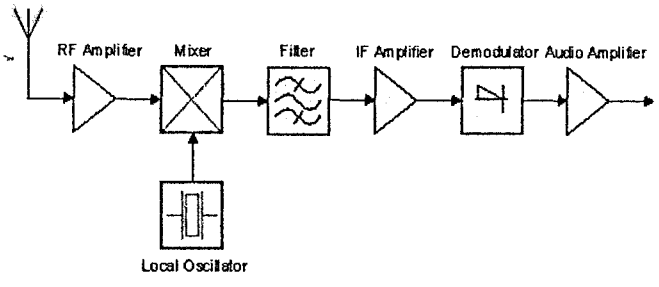

Figure 4. AM receiver block diagram

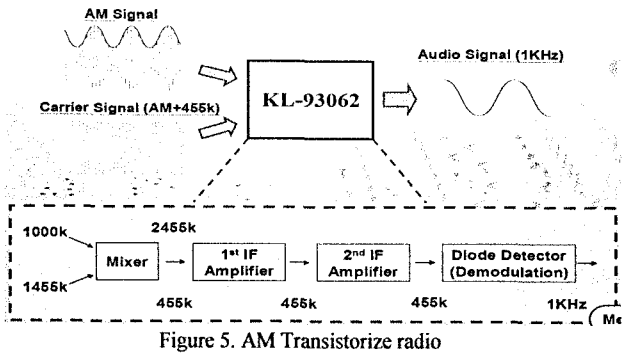

Figure 5. AM Transistorize radio

During the demodulation process in receiver, the receiver signals undergo two or more frequency translation. First, the RF is converted to IF, and then the IF converted to the source information. In RF section, generally consist of pre-selector and an amplifier stage. This pre-selector is a broad-tuned band-pass filter with an adjustable center frequency that is tuned to the desired carrier frequency. This pre-selector can provide enough initial band-limiting to prevent a specific unwanted radio frequency from entering receiver and also reduce the noise bandwidth. The advantages of an amplifier are improve image frequency rejection, better signal to noise ratio, better selectivity and better sensitivity.

In mixer section, the purpose of the mixer is to convert radio frequencies to intermediate frequencies (RF to IF frequency translation). The shape of the envelope remains the same and also the original information contained in the envelope remain unchanged when the carrier and sideband frequencies are translated from RF to IF.

The IF section consist of a series of IF amplifier and band-pass filter. The center frequencies and bandwidth of IF are constant for all stations and are chosen so that their frequency is less than any RF to construct high gain and stable amplifier for the low frequency signals. The detector section's purpose is to convert the IF signal back to the original source information. [3]

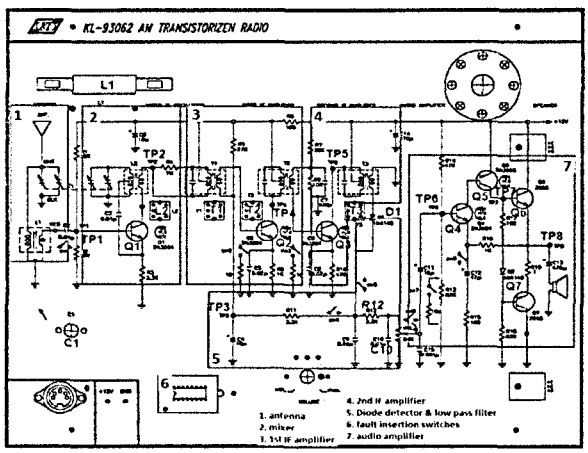

Figure 6. AMIDS13 receiver module KL-93062

The received AM signal from the antenna is decided by C1, L1. Variable capacitor C1 selects the desired AM signal (assume X kHz) and also generates the frequency of the carrier signal (combines with L2) for the mixer Q1. The frequency of the local oscillator is equal to X + 455 kHz. The mixer Q1 mixes the signal of the received AM signal (x kHz) and local oscillator (x+455 kHz), resetting the output signal from (2x + 455k) and (455k Hz) at TP2. Transformer T1 couples the 455 kHz IF signal to Q2 for IF signal amplification. Transformer T2 couples the 455 kHz IF signal to Q3 for IF signal amplification. Transformer T3 couples the 455 kHz IF signal to D1 to rectify the half cycle of the IF signal. The output of D1 feed to a Low Pass Filter (R12+C10) to reconstruct the original audio signal. The output voltage of D1 which is proportional to the strength of the received RF signal is fed back to the first IF amplifier for Automatic Volume Control (AVC) – to reduce the volume variations between week and strong stations. Q4 is the audio amplifier; the gain is adjusted by the VOLUME variable resistor. Q5, Q6 and Q7 are power amplifiers used to drive the loudspeaker. The urgency of this research is to address the first postulated theory which is readability problem. This paper was identifying the readability of Amplitude Modulation Transmitter and Receiver Lab Manual [4].

II. METHODOLOGY

A lab manual is a booklet with the set of instruction and procedure with the aim to guide students in conducting an experiment. A lab manual should be able to guide students and it is a technical communication document that can supersede the lecturer or technician during lab session. It should be able to demonstrate clear and concise language, so that the students could understand the lab instructions with minimum ambiguity. Ambiguities within the lab manual can be due to grammar or language error, missing information, complex written structure and much more.

Readability can be described as the ease of the document can be read. The readability test can be defined as a mathematical formula that designed to assess a suitability of a particular document for a particular grade level or ages. The purpose of readability test is to help educators and publishers to make a decision for a suitable any reading. Some people define the term of "readable" as fit to be read, interesting, agreeable and attractive in term of style and also enjoyable [5].

There are several techniques of identifying readability. For this research, the focus is Flesch Reading Ease, Flesch-Kincaid grade level and Gunning-Fog Index. These types have their own weighted factor so that the result will be different correlate approximately inversely.

Flesch Reading Ease, Flesch-Kincaid Grade Level and Gunning Fog Index are reading level algorithm that can be helpful in determining on how readable the document. However, reading level algorithm can be providing a rough guide. Readability test can be performed manually a mathematical calculation. Most grammar or editing software today can perform several readability tests.

A. Flesch Reading Ease

To identify the score, the following procedure must be adhered:

1. Calculate the average number of words used per sentence.
2. Then, multiply the average numbers of words per sentences multiplied by 1.015.
3. Subtract it with the average number of syllables per words multiplied by 84.6.
4. Subtract the result from 206.835 to get the score.

$$206.835 - 1.015\left(\frac{\text{Total words}}{\text{Total sentences}}\right) - 84.6\left(\frac{\text{Total syllables}}{\text{Total words}}\right) \quad (1)$$

The Flesch Reading Ease score is an index number that rates the text on a 100-point scale. The higher the score, the easier it is to understand the document. Authors are encouraged to aim for a score of approximately 60 to 70 [6].

TABLE 1:FLESCH READING EASE SCORE.

Score	Notes
90.0–100.0	Easily understandable by an average 11-year-old student
60.0–90.0	Easily understandable by 13- to 15-year-old students
0.0–60.0	Best understood by university graduates

B. Flesch-Kincaid Grade Level

To identify the score, the following procedure must be adhered:

1. First calculate the average number of words used per sentence.
2. Then, multiply the average numbers of words per sentences by 0.39.

3. Add it to the average number of syllables per word multiplied by 11.8.
4. Subtract 15.50 from the result.

$$0.39\left(\frac{Total\ words}{Total\ sentences}\right)+11.8\left(\frac{Total\ syllables}{Total\ words}\right)-15.59 \quad (2)$$

It is a rough measure of how many years of schooling it would take someone to understand the content. The negative results are reported as zero, and numbers over twelve are reported as twelve [7].

TABLE 2: THE FLESCH KINCAID GRADE LEVEL SCORE.

Flesch Kincaid Grade Level	Typical Age	Style Description
1	6-7	
2	7-8	
3	8-9	
4	9-10	
5	10-11	Very easy
6	11-12	Easy
7	12-13	Fairly easy
8	13-14	Standard
9	14-15	Standard
10	15-16	Fairly difficult
11	16-17	Fairly difficult
12	17-18	Fairly difficult
13	18-19	Difficult
14	19-20	Difficult
15	20-21	Difficult
16	21-22	Difficult

C. Gunning Fog Index

The researcher used another readability test name Gunning Fog Index. The Gunning FOG index is a test designed to measure the readability of a sample of English writing based on sentence length. It is also designed to make sure the text can be read easily by the audience. The test is based on an estimate which is calculated as to the number of years of formal education that a person needs in order to understand the sample on the first read through.

To identify the score, the following procedure must be adhered:

1. First calculate the average number of words used per sentence.
2. Add it to the average number of complex words per total words multiplied by 100.
3. Then multiply by 0.4.

$$0.4\left(\left(\frac{Total\ words}{Total\ sentences}\right)+100\left(\frac{Complex\ words}{Total\ words}\right)\right) \quad (3)$$

Generally, the ideal score for readability with the fog index is 7 or 8. Anything above 12 is too hard for most people to read. For example, the new manual lab has a FOG index of 12.2, Time magazine is about 11. To write clearly and well, generally use short words and short sentences. The FOG index works to simplify written work for ease understanding. However, the FOG index also encourages low writing styles which may indirectly result in dull and uninteresting text written [8].

III. RESULT AND DISCUSSION

TABLE 3: TEXT STATISTIC (INITIAL)

Text statistic	
No of sentences	96
No of words	867
No of complex words	113
Percent of complex words	13.03%
Average word per sentences	9.03
Average syllables per word	1.51

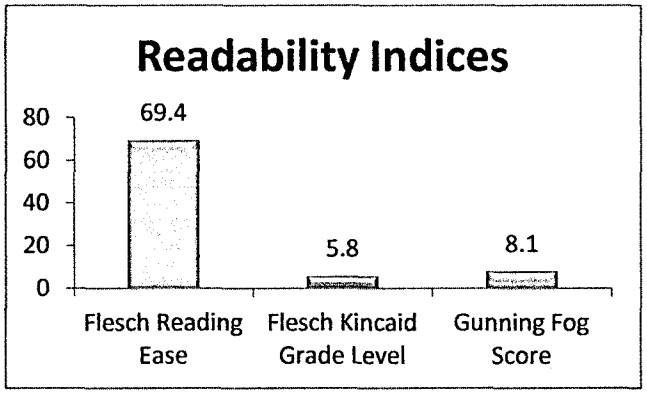

Figure 7.Readability result (Initial)

The initial lab manual has 96 sentences, while the number of words is 867, number of complex words is 113, percent of complex words is 13.03%, Average word per sentences is 9.03, and the average syllables per word is 1.51.

The readability test results indicate that the readability Flesch Reading Ease factor was identified as 69.5. This implies that, a person age 12 or more should be able to read and understand lab manual. Additionally, the

initial lab manual was tested against Flesh Kincaid Grade Level test and this resulted in a score of 5.8. This implies that the lab manual is easy to read. It also uses Gunning Fog Index to calculate the score. The result yields score of 8.1 and this imply that the text is easy to understand for a wide audience with the first reading.

The researcher identifies several key issues to be addressed now to make improvement to the lab. Firstly the lab lacks of critical information with regard to procedure. The researcher observes that these missing information of a cause ambiguity and confusion to the students.

Additionally, there was no literature reviews made available in the lab manual. Based on these issues, the researcher makes an effort to improve the readability factor.

Table four (4) and Figure eight (8) shows and illustrate the new text statistics and readability indices improve in the lab manual.

TABLE 4: TEXT STATISTIC (IMPROVED)

Text statistic	
No of sentences	139
No of words	1643
No of complex words	245
Percent of complex words	14.91%
Average word per sentences	11.82
Average syllabus per word	1.56

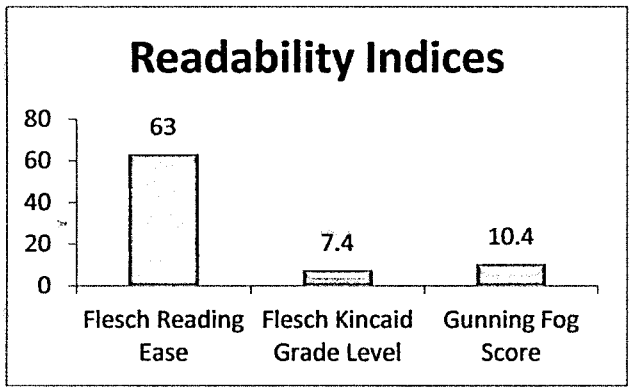

Figure 8.Readability result (Improved)

After a full analysis of the lab manual, the readability test results indicate that the readability Flesch Reading Ease factor was identified as 63. It demonstrates that the current lab manual is readable from 13 to 14 years old students. This implies that the lab manual is medium to read while the reading Flesch Kincaid Grade Level was determent at 7.4and the Gunning Fog test result yields a score of 10.4. This implies that the text is medium to understand for a wide audience with the first reading.

The improve lab manual has 139 sentences, while the number of words is 1643, number of complex words is 245, percent of complex words is 14.91%, Average word per sentences is 11.82, and the average syllables per word is 1.56.
This indicates that there are have additional information in the improve lab manual and this will result the higher score compared to the initial lab manual.

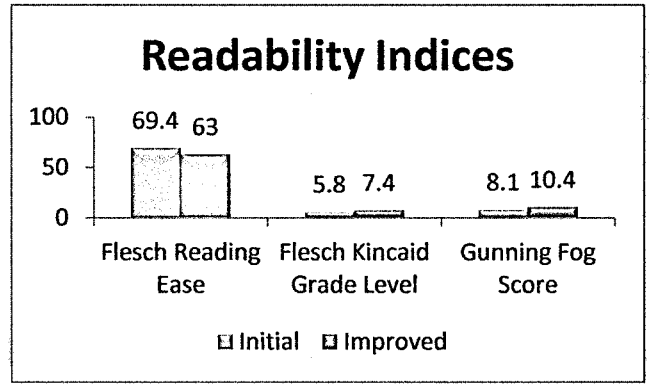

Figure 9.Comparison between Initial and Improved lab manual

Figure 9 illustrates the comparison of readability indices for both initial and improve lab manual. From the figure, it can clearly be seen that there is a drop in Flesh Reading Ease. However, there is an increase in Flesch Kincaid Grade Level and Gunning Fog Index. These infer that those aged 14 and above should be able to read and understand lab manual. These mean there is an increase of 2 education year, that being (12 years old) to (14 years old). Generally UITM Engineering students should not have the problem on reading the lab manual, this is because of the students is above 20 years old. However, since many UiTM Engineering students are not a native English user, such comparison is deemed premature.

Even though readability reduced, the researcher believes such changes necessary because the changes may encourage students to understand the lab and it is hoped that with review made to the manual, the student will find it easier to read and understand the lab as a whole.

IV. CONCLUSION

The researcher has successfully investigated the readability of AM Transmitter and Receiver Lab Manual. Initially, the lab manual was determined as easy to read with those above 14 years old should have no problem reading and understand the lab manual. Changes were taken to improve the readability of the lab manual but this has resulted in a negative impact on the readability factor. In general, the improved lab manual is slightly more difficult to read and understand as compared to initial lab manual. However, these

changes were thought to be critical and important to ensure student understanding in the lab session.

V. RECOMMENDATION

Researches come out with several recommendations that may improve the current lab session. First, the lab manual should have pre-lab activities, such as question for students to answer prior to the lab session. It is postulated it may enhance the lab session. The second recommendation is, they should be a theoretical session at the beginning of each lab session, this also met to enhance to the understanding. Finally, the researcher recommends that the faculty introduces an introductory class at the beginning of each semester. This introductory class should focus on the use of lab equipment such as oscilloscope, safety measure and many more.

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