Homework 6B – SystemC AMS Modeling - TDF

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I. Introduction

In this homework, we are about to make an AM Modulation using *SystemC-AMS* TDF and ELN elements.

II. Band Pass Filter Implementation

A. *Message and Carrier Sine Wave in SystemC-AMS*

To produce the *Message* and *Carrier* sine wave, we simply measure sin(2πft) which f is the frequency of the signal and t is the current time.

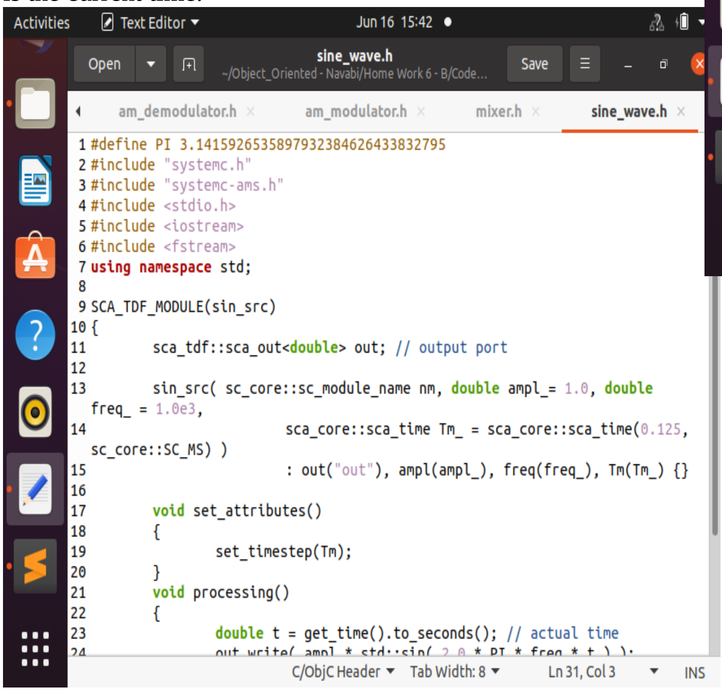

Fig. 1 *Sine Wave Generator SystemC-AMS*

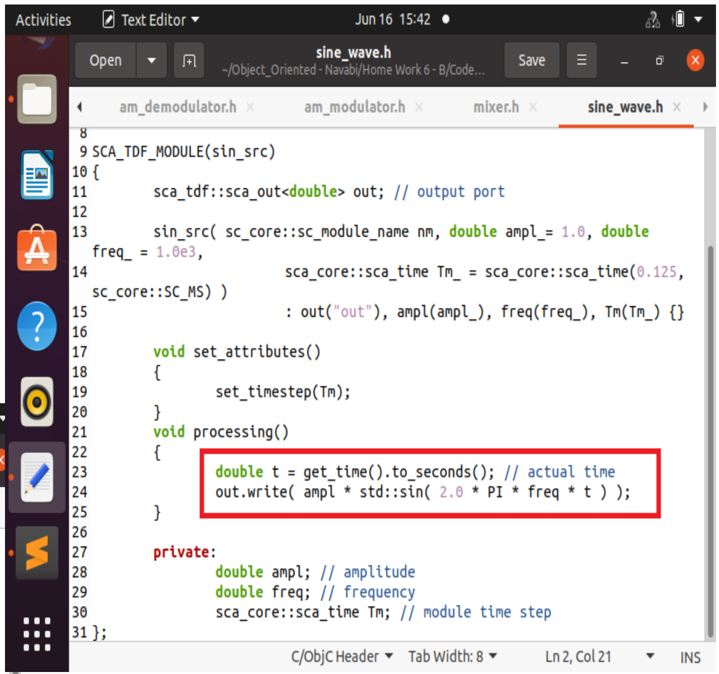

Fig. 2 *Sine Wave Generator SystemC-AMS*

B. *Mixer in SystemC-AMS*

First in the method "*set_attributes*" the sampling rate of the *Message* and the *Carrier* signals are defined. Due to the Nyquist theorem the sampling frequency must be at least 2 times greater than the frequency of the original signal, so the rate of the *Message* signal is set to 20KHz (2*10KHz) and the rate of the *Carrier* signal is set to 2MHz (2*1MHz).

Fig. 3 *Mixer SystemC-AMS*

Then in a loop, *C(t) + m(t)*C(t)* is calculated for each sample and written in the output (*modulated_signal*). As the *Carrier* frequency is 100 times greater than the *Message* frequency, in this loop we use the same *Message* sample for all *Carrier* samples, because whenever 100 samples of the *Carrier* is received, just 1 sample of the *Message* is collected so this sample is used for all *Carrier* samples.

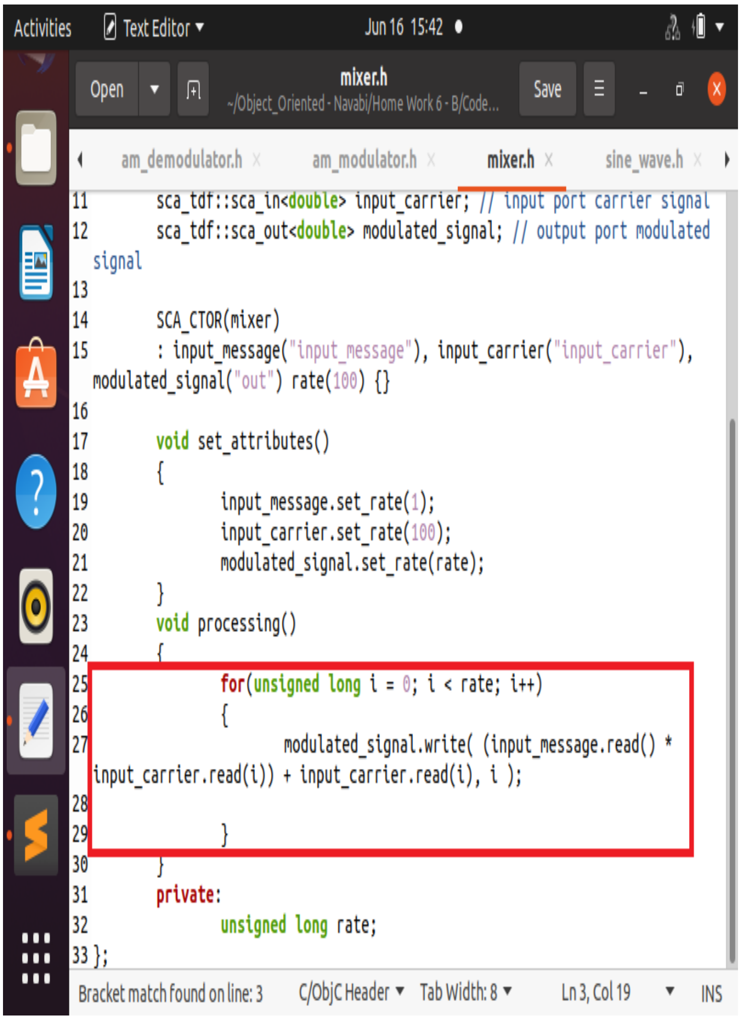

Fig. 4 *Mixer SystemC-AMS*

C. AM Modulator in SystemC-AMS

First two sine wave sources are made to produce the 10KHz *Message* and the 1MHz *Carrier* signals. Then a *Mixer* is made to mix the *Message* and *Carrier* signals, so the outputs of the sine sources are connected to the inputs of this module. The output of the *Mixer* is the *AM* modulated signal of the *Message*.

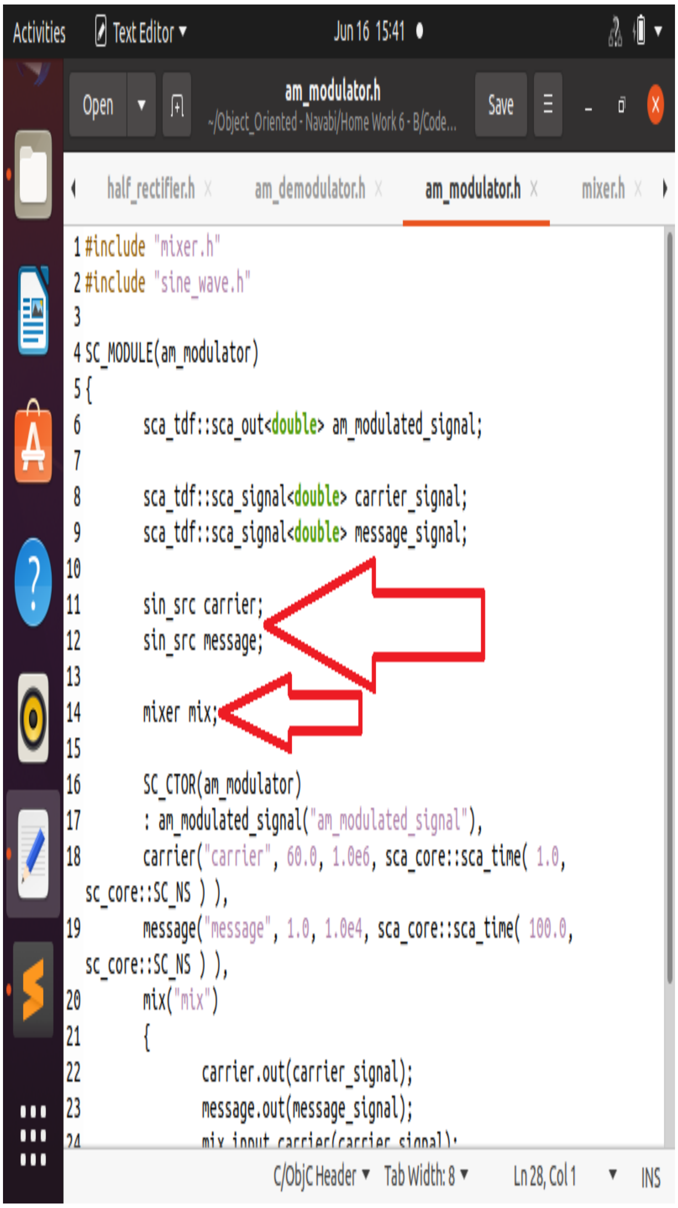

Fig. 5 *AM Modulator SystemC-AMS*

Carrier is much faster than the *Message* sine wave so the time step of the *Carrier* must be much less than the Message signal, because of that the time step of the *Carrier* and *Message* signals are set to 1 and 100 nano seconds respectively.

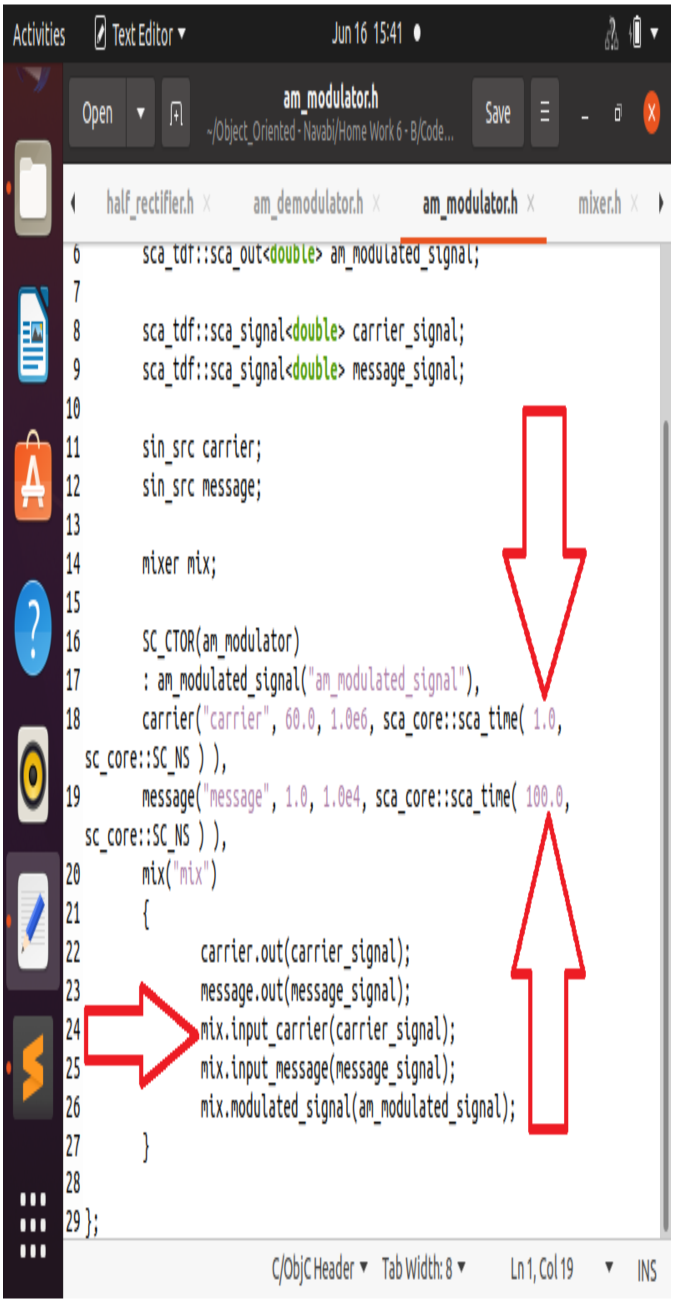

Fig. 6 *AM Modulator SystemC-AMS*

D. Half-Wave Rectifier in SystemC-AMS

To half rectify the input signal, we simply check the input. If the input is negative (less than 0) the output will be equal to the input, else the output will be zero

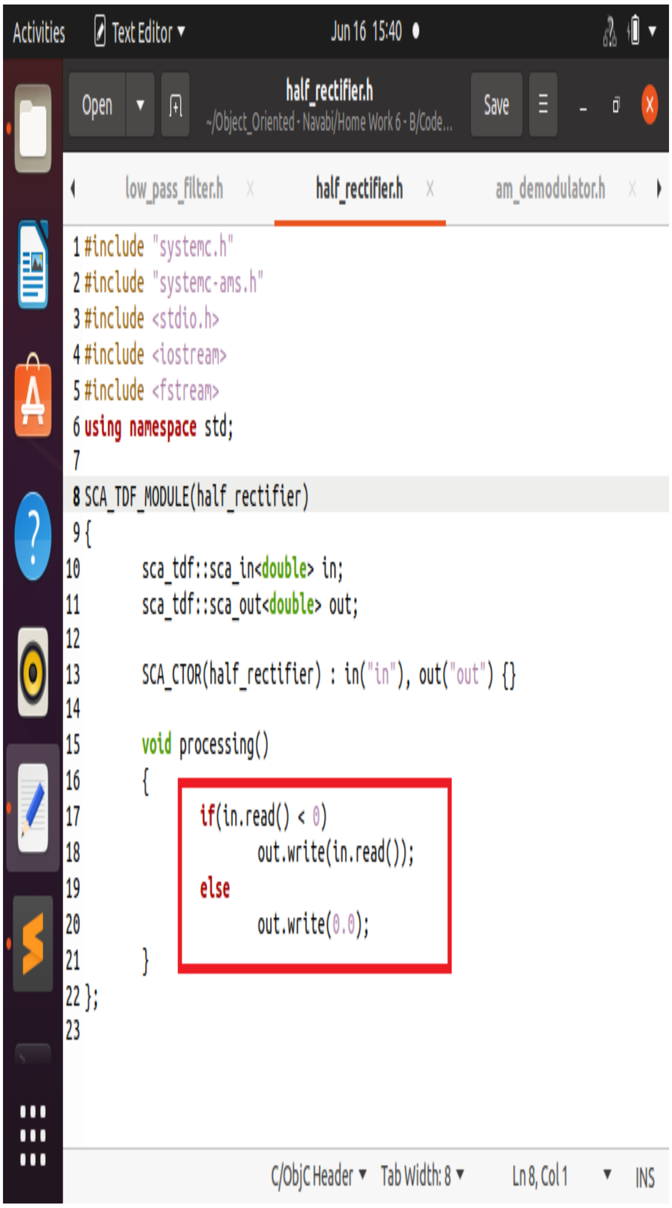

Fig. 7 *Half-Wave Rectifier SystemC-AMS*

E. RC Low-Pass Filter in SystemC-AMS

To filter the modulated signal and recover the message, a *RC Low-Pass Filter* is needed. To design this *RC Low-Pass Filter*, a resistor (Rf) and a capacitor (Cf) are defined. To convert the tdf input signal to an eln signal and convert the output eln signal to a tdf signal, a tdf to eln converter and an eln to tdf converter are used.

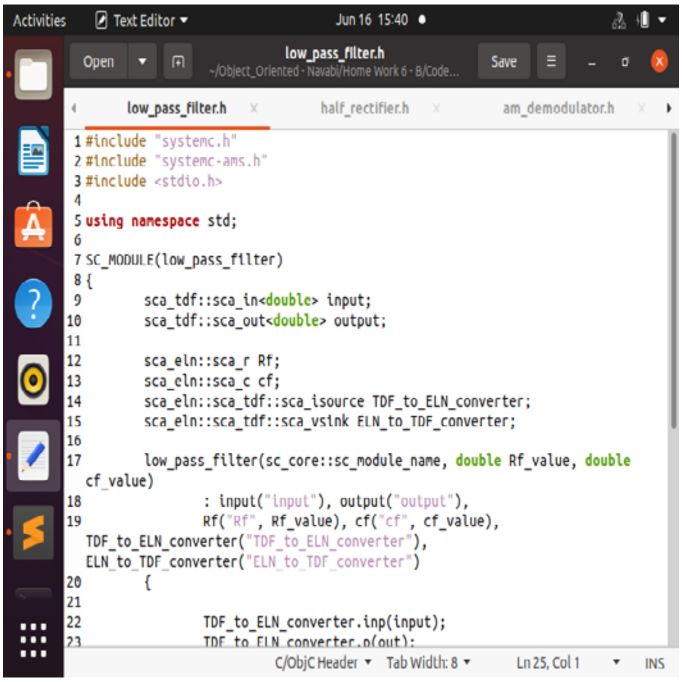

Fig. 8 RC Low-Pass Filter *SystemC-AMS*

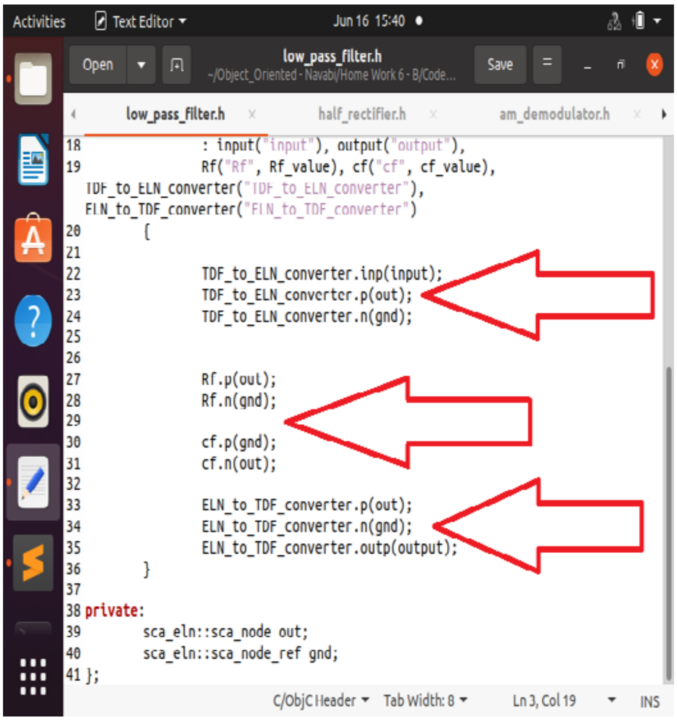

Fig. 9 RC Low-Pass Filter *SystemC-AMS*

F. AM Demodulator in SystemC-AMS

Simply an instance of *Half-Wave Rectifier* and RC *Low-Pass Filter* are taken. The output of the *Half-Wave Rectifier* (Half_Rectifier_out) is connected to the input of the RC *Low-Pass Filter*. The output of the *RC Low-Pass Filter* is the recovered *Message* signal. As the cutoff frequency of an RC Low-Pass Filter is equal to 1/2πRC, and the filter must pass frequencies between *Message* and *Carrier* frequencies, so we choose R = 2 and C = 1u to have a 2MHz cutoff frequency, to pass the frequencies between *Message* and *Carrier* frequencies through the filter.

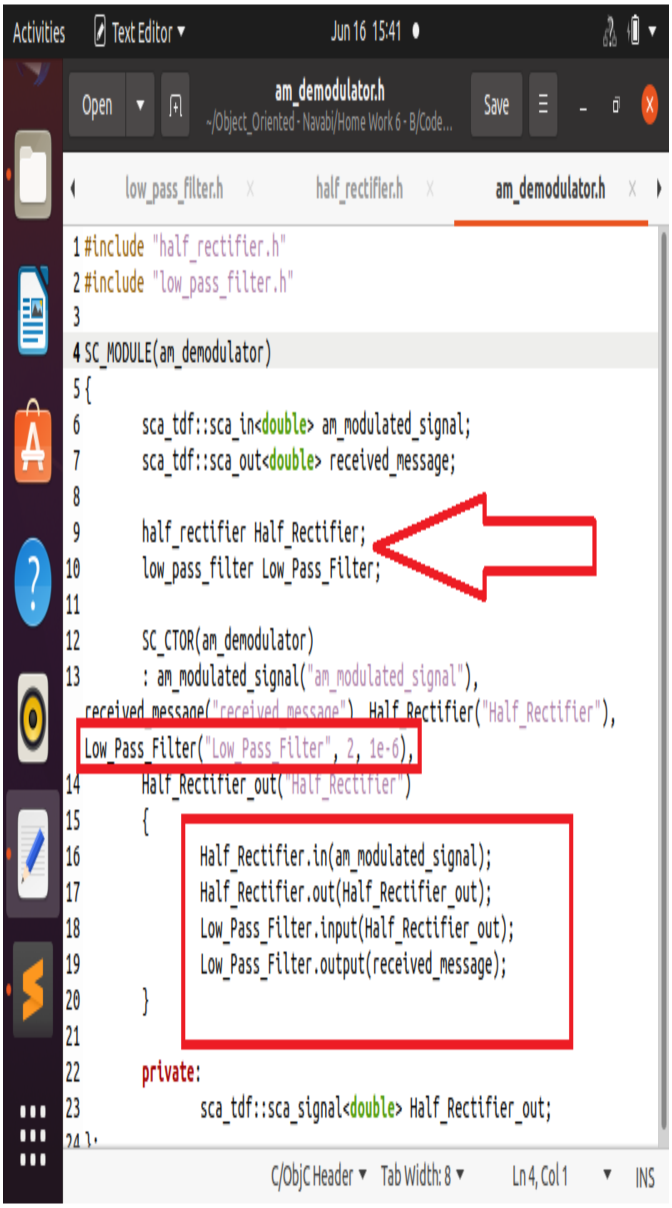

Fig. 10 *AM Demodulator SystemC-AMS*

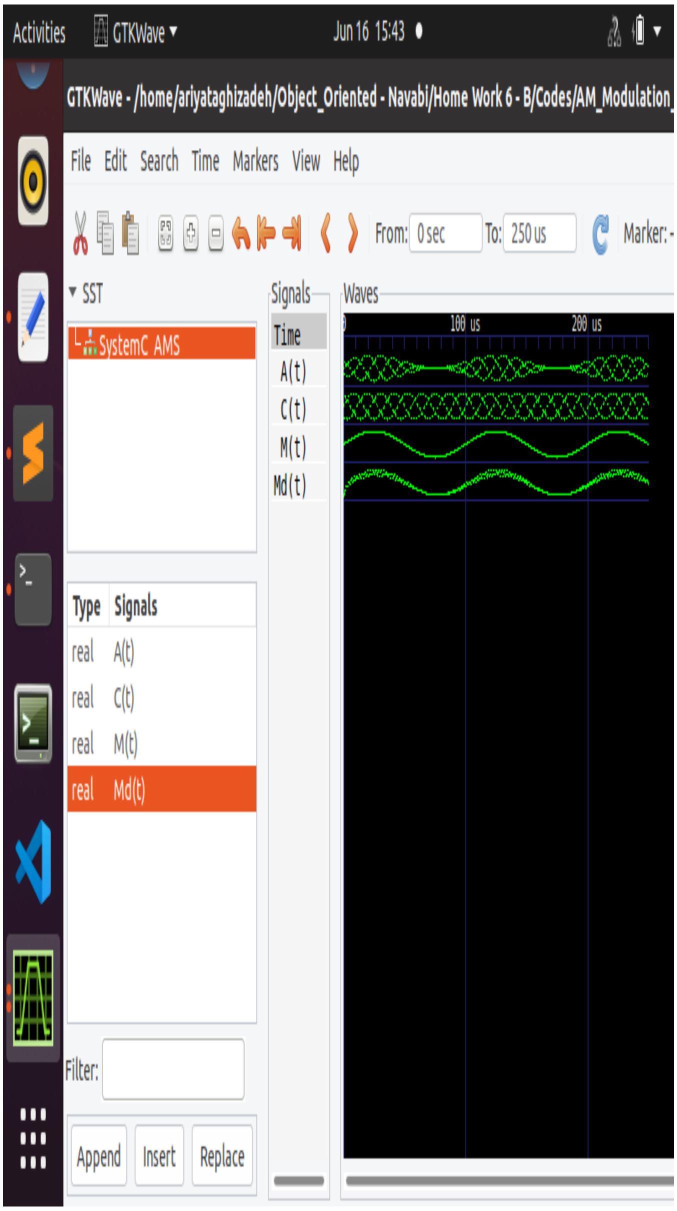

Fig. 11 *AM Modulation Test Bench Results*