BIRZEIT UNIVERSITY

Faculty of Engineering and Technology

Department of Electrical and Computer Engineering

First Semester 2021/2022

Communication Systems ENEE 3309

Course Project

Instructors: Dr. Wael Hashlamoun and Dr. Ashraf Rimawi

About the course project:

- **General Description:**

  This project will cover amplitude modulation and demodulation. A normal AM waveform is produced using a simple switching modulator circuit. The resulting AM waveform is then demodulated using an envelope detector circuit. It requires the students to write Matlab Code for plotting modulated, and demodulated signals in both time and frequency domains. Evaluating the optimum value of the time constant that minimizes the mean square error between modulated signal and the output signal of the envelope detector.

- The projects will be graded based on a project report (of around 2-3 pages) and short presentations (or discussion in our offices) during the last week of December.

- Report should include Matlab code (m-file) and your results.

- Project submission must be via Moodle only (itc.birzeit.edu), but please use PDF format and **not** Word.DOC files, if possible, since we often have formatting problems with Word files.

- The deadline for submitting your report on itc: Sun. 05 Dec. 2021 (23.59 PM).

- **Project Description:**

Consider the AM signal

$$s(t) = A_c[1 + \mu \cos(2\pi f_m t)]\cos(2\pi f_c t)$$

1. Use Matlab (m-file commands) to plot $s(t)$ assuming $\mu = 0.25$, $A_c = 1$, $f_m = 1\text{Hz}$, $f_c = 25\text{Hz}$ over two cycles of the message $m(t) = \cos(2\pi f_m t)$
2. If $s(t)$ is passed through an ideal envelope detector, plot the demodulated signal over two cycles of the message $m(t)$.
3. Assume that $s(t)$ is passed through the envelope detector shown in the figure to produce the waveform $y(t)$, where $R_s = 0$ and the diode is ideal ($V_D = 0$). In class, we put the following condition on the time constant of the circuit for best performance

$$\frac{1}{f_c} \ll \tau = R_L C \ll \frac{1}{f_m}$$

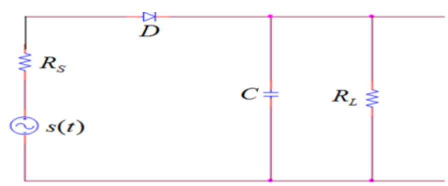
Define the mean squared error between $s(t)$ and $y(t)$ as:

$$D = \frac{1}{T_m}\int_0^{T_m} (y(t) - m(t))^2 dt$$

a. Plot D versus $\frac{1}{f_c} \le \tau \le \frac{1}{f_m}$

b. From the figure, determine the optimum value of the time constant that minimizes D.

c. Plot $y(t)$ that corresponds to the minimum D



HINT:

$$V_{out} = \begin{cases} V_o e^{-\frac{t}{\tau}} & Diode\ is\ off \\ s(t) & Diode\ is\ on \end{cases}$$

where

V_{out} is the voltage at the output of the envelop detector

Vo is the value of s(t) just before the diode turns off

The time constant $\tau = RC$.