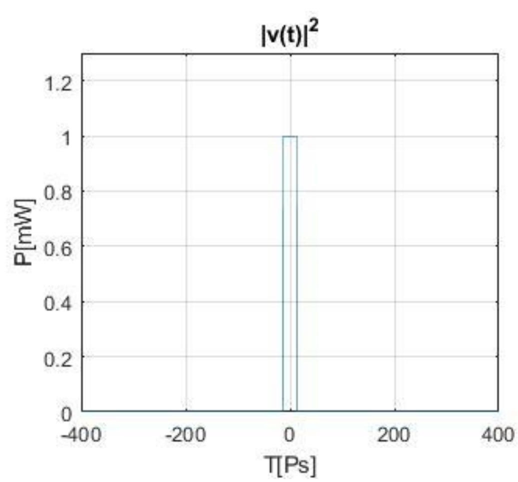
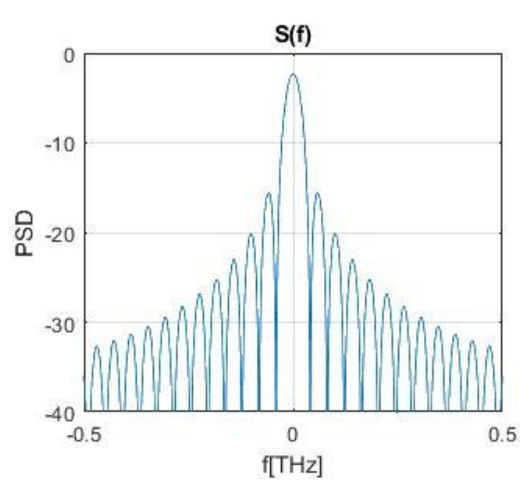
Mohammed Alabadsa **Student ID: 28G21130**

```
clear all; close all; clc;

A = 1;
tau = 25;    %ps
T = 1024;    %FFT window size (ps)
N = 2048;    % number of sampling

dt = T/N;    %time interval
df = 1/T;    %frequency interval

t = -T/2 : dt : T/2-dt; %time vector
f = -N*df/2 : df : N*df/2-df; %frequency vector

vt = A * (abs(t) < tau/2);  %Rectangular Pulse
Vf = fftshift(fft(vt));     %Fourier transform of Rect. Pulse

%Plot Rect Pulse
figure('Position',[100 100 800 300])
subplot(121)
plot(t,abs(vt).^2)
ylim([0 1.3])
xlim([-400 400])
title('|v(t)|^2')
xlabel('T[Ps]')
ylabel('P[mW]')

%Plot PSD
subplot(122)
plot(f, 10*log10(abs(Vf).^2/N*dt))
ylim([-40 0])
xlim([-0.5 0.5])
title('S(f)')
xlabel('f[THz]')
ylabel('PSD')

% check Parcevals theorem
Pave_t = mean(abs(vt).^2);
Pave_f = sum(abs(Vf).^2/N*dt*df);
% Pave_t = Pave_f = 0.0239
```





Mohammed Alabadsa **Student ID: 28G21130**

$$V(t) = \begin{cases} 1, & |t| \leqslant \tau/2 \\ 0, & \tau > \tau/2 \end{cases} \qquad \tau = 25\ Ps$$

find $V(f) = ?$

$$V(f) = \int_{-\infty}^{\infty} v(t)\exp(-j2\pi f t)\,dt$$

$$= \int_{-\tau/2}^{\tau/2} e^{-j2\pi f t}\,dt \qquad \left(\int e^{2x}dx = \frac{1}{2}e^{2x} + c\right)$$

$$= \frac{-1}{j2\pi f}\left(e^{-j2\pi f t}\Big|_{-\tau/2}^{\tau/2}\right)$$

$$= \frac{-1}{j2\pi f}\left(e^{-j\pi f\tau} - e^{j\pi f\tau}\right)$$

$$= \frac{1}{\pi f}\underbrace{\left(\frac{e^{j\pi f\tau} - e^{-j\pi f\tau}}{2j}\right)}_{\sin(\pi f\tau)}$$

$$= \tau\,\frac{\sin(\pi f\tau)}{\pi f\tau}$$

$$= \boxed{\tau\ \operatorname{sinc}(\pi f\tau)}$$