CT 303 - Lab 05

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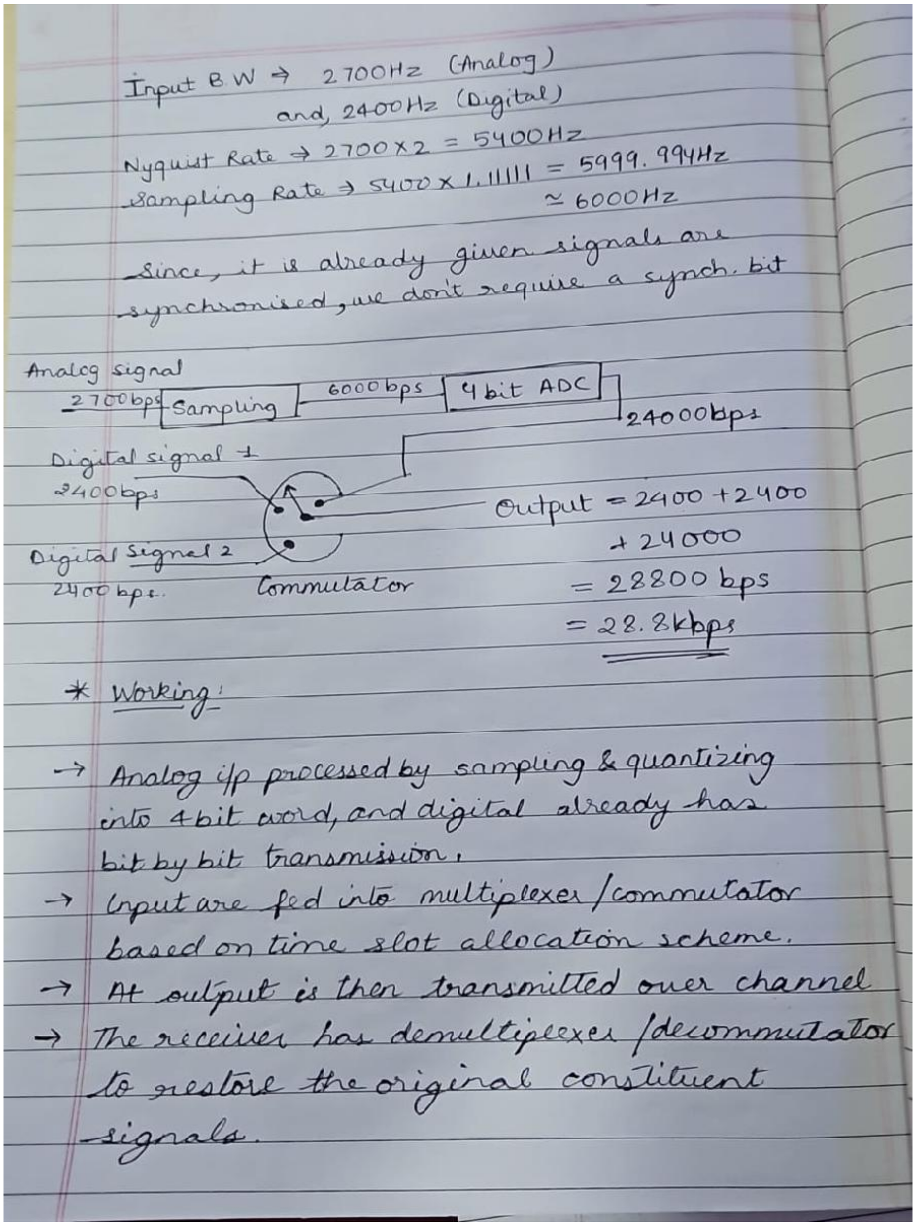
Question 1



Input B.W → 2700Hz (Analog)
and, 2400Hz (Digital)

Nyquist Rate → 2700 × 2 = 5400Hz
Sampling Rate → 5400 × 1.11111 = 5999.994Hz
≃ 6000Hz

Since, it is already given signals are synchronised, we don't require a synch. bit

Output = 2400 + 2400 + 24000
= 28800 bps
= 28.8kbps

* Working:

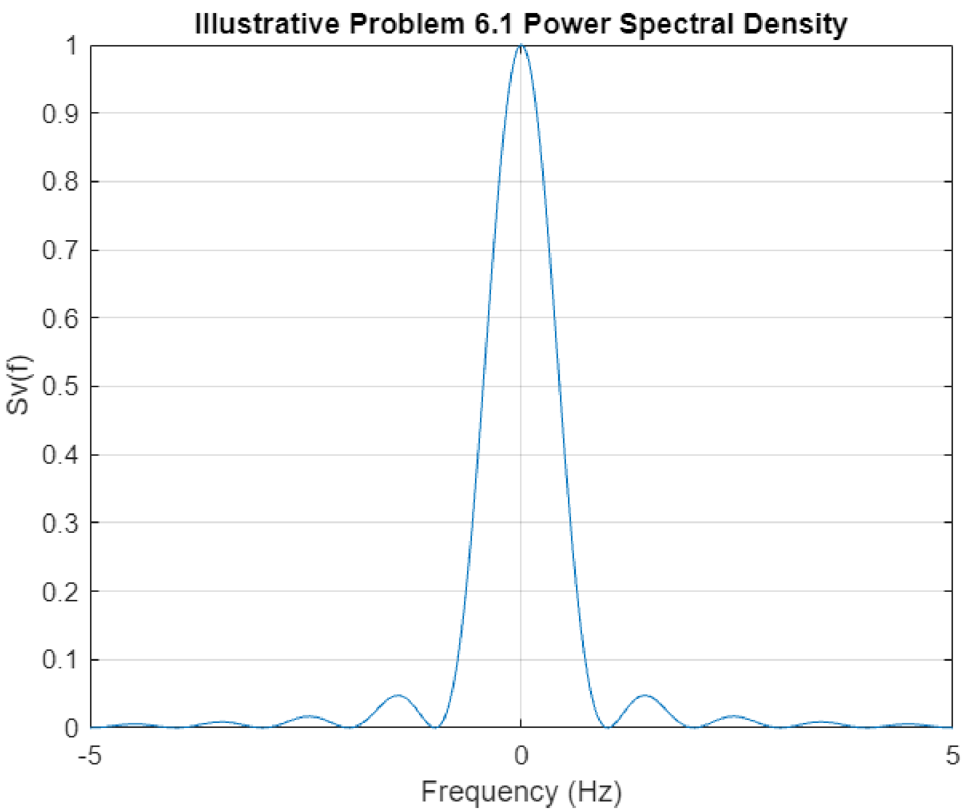
→ Analog i/p processed by sampling & quantizing into 4bit word, and digital already has bit by bit transmission.
→ Input are fed into multiplexer/commutator based on time slot allocation scheme.
→ At output is then transmitted over channel
→ The receiver has demultiplexer/decommutator to restore the original constituent signals.

Question 2

6.1

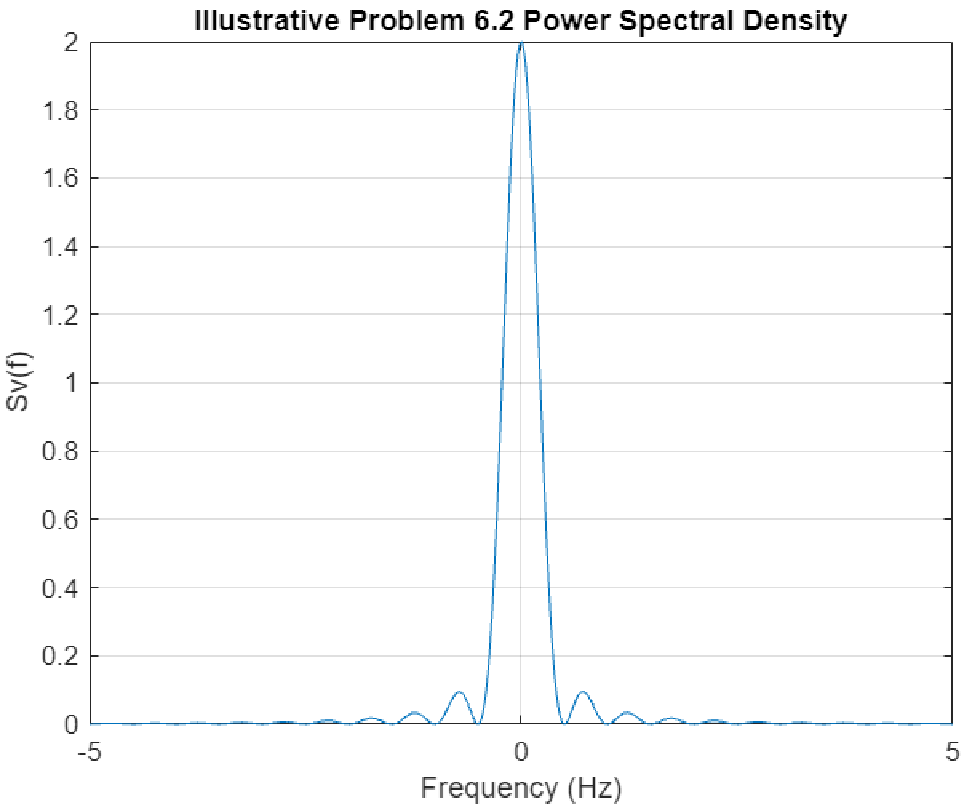
```
T = 1;
delta_f = 1/(100*T);
f = -5/T:delta_f:5/T;
```

```
sigma_a = 1;
Sv = sigma_a^2*sinc(f*T).^2;
plot(f,Sv);
title('Illustrative Problem 6.1 Power Spectral Density');
xlabel('Frequency (Hz)');
ylabel('Sv(f)');
grid on;
```



6.2

```
T = 1;
delta_f = 1/(100*T);
f = -5/T:delta_f:5/T;
Sv = 2*(cos(pi*f*T).*sinc(f*T)).^2;
plot(f,Sv);
title('Illustrative Problem 6.2 Power Spectral Density');
xlabel('Frequency (Hz)');
ylabel('Sv(f)');
grid on;
```

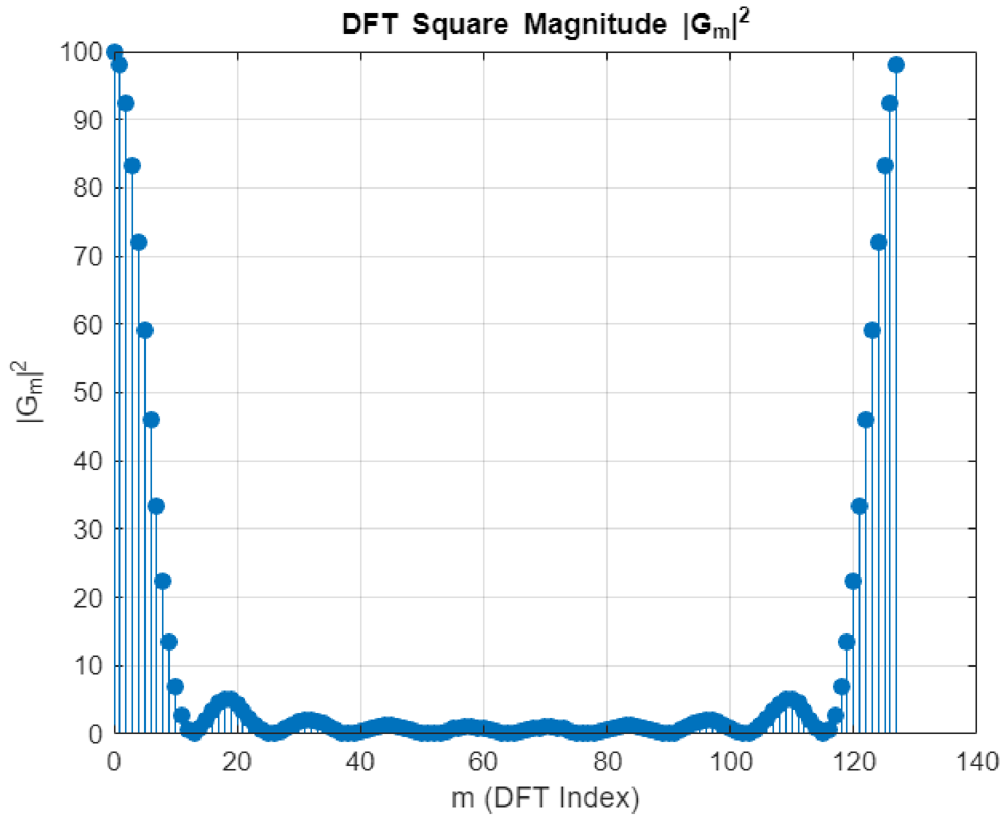


Question 3

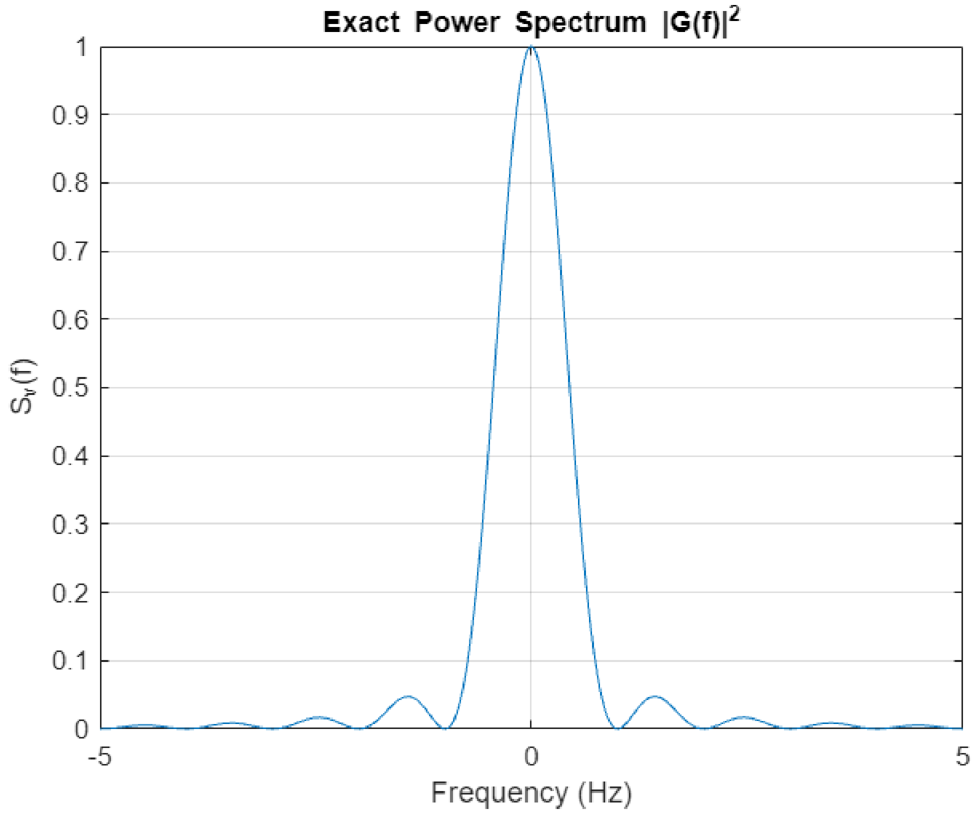
6.1

```
%Parameters
T = 1;
sigma_a = 1;
N = 128;
t = (0:N-1)/10;

%Rectangular pulse
g = double(t<T);

%Calculate 128 point DFT using FFT
G = fft(g,N);

%Calculate sq. magnitude of DFT
G_sq_mag = abs(G).^2;

%Exact spectrum
delta_f = 1/(100*T);
f = -5/T:delta_f:5/T;
Sv = sigma_a^2*sinc(f*T).^2;

%Plot
figure;
```

```
stem(0:N-1,G_sq_mag,'filled');
title('DFT Square Magnitude |G_m|^2');
xlabel('m (DFT Index)');
ylabel('|G_m|^2');
grid on;
```



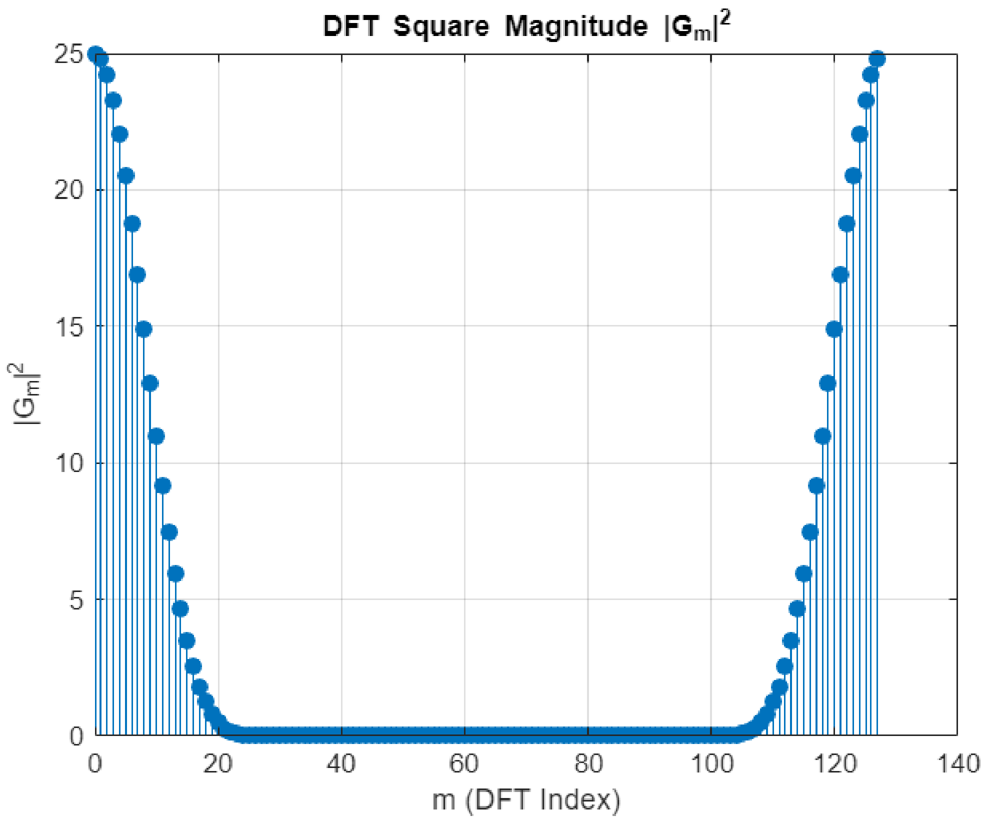

```
figure;
plot(f,Sv);
title('Exact Power Spectrum |G(f)|^2');
xlabel('Frequency (Hz)');
ylabel('S_v(f)');
grid on;
```



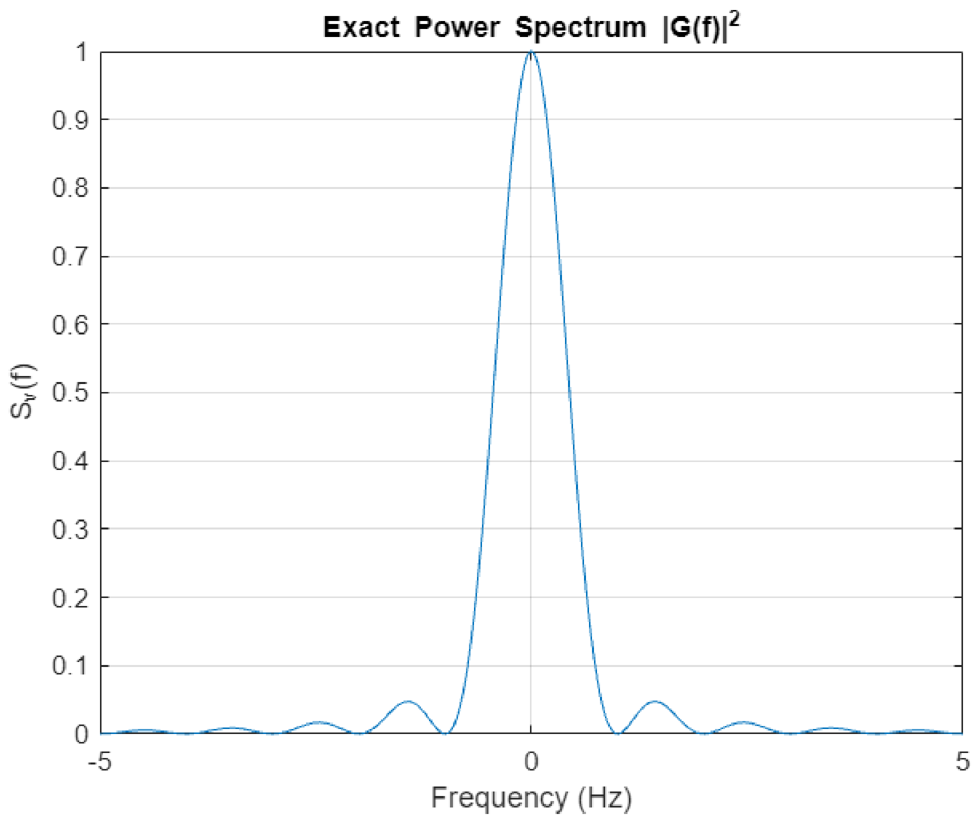
6.2

```
%Parameters
T = 1;
sigma_a = 1;
N = 128;
t = (0:N-1)/10;

%Redefined Pulse
g = 0.5 * (1 - cos(2 * pi * t / T)) .* (t >= 0 & t <= T);

%Calculate 128 point DFT using FFT
G = fft(g,N);

%Calculate sq. magnitude of DFT
G_sq_mag = abs(G).^2;

%Exact spectrum
delta_f = 1/(100*T);
f = -5/T:delta_f:5/T;
Sv = sigma_a^2*sinc(f*T).^2;

%Plot
figure;
stem(0:N-1,G_sq_mag,'filled');
title('DFT Square Magnitude |G_m|^2');
```

```
xlabel('m (DFT Index)');
ylabel('|G_m|^2');
grid on;
```



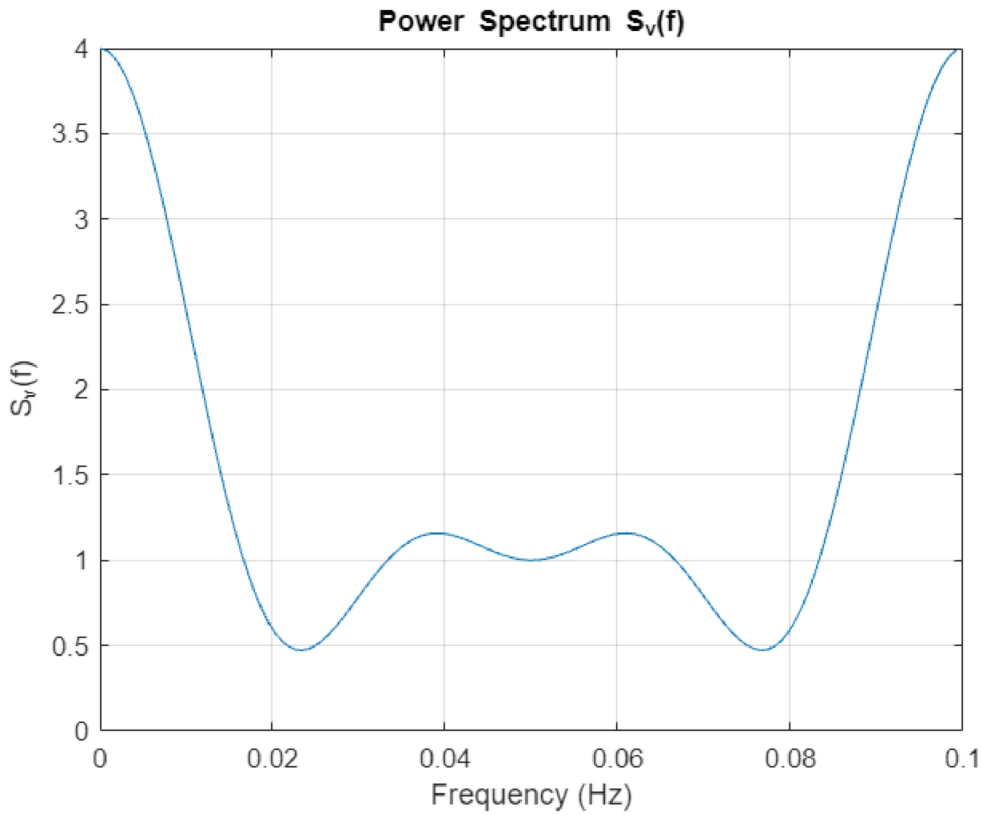

```
figure;
plot(f,Sv);
title('Exact Power Spectrum |G(f)|^2');
xlabel('Frequency (Hz)');
ylabel('S_v(f)');
grid on;
```



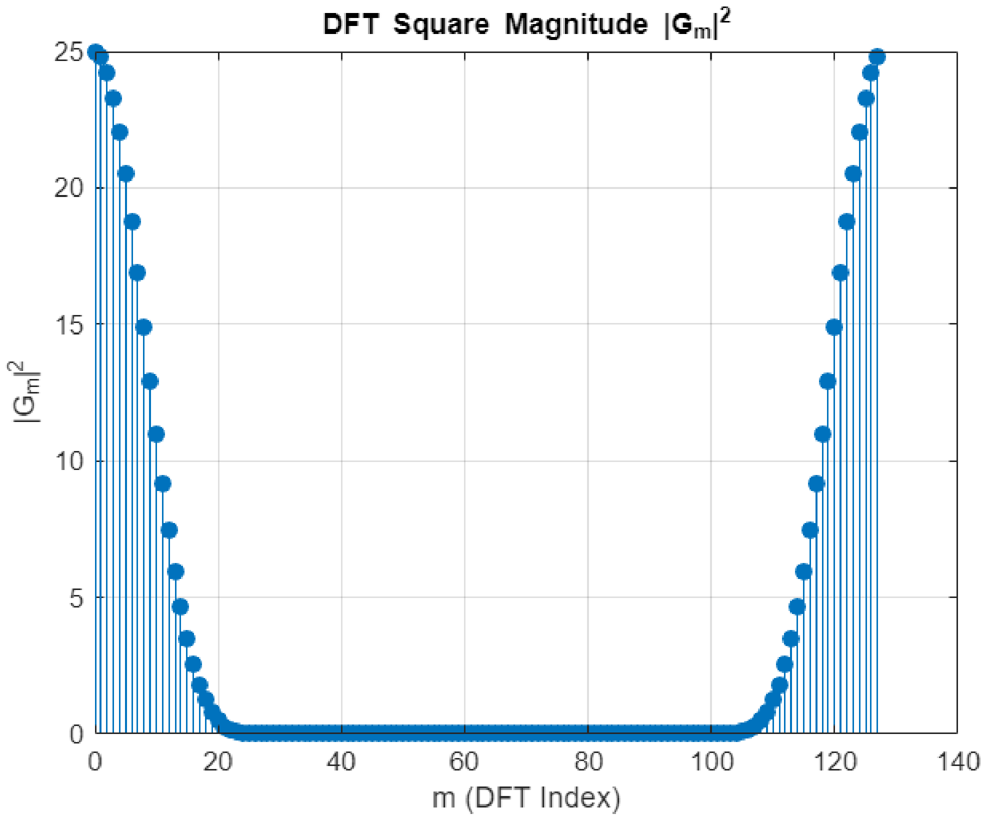
6.3

```
% Parameters
T = 1;                  % Duration of the rectangular pulse
sigma_a = 1;           % Amplitude scaling factor
N = 128;               % Number of points
t = (0:N-1)/10;        % Time vector

% Modified pulse g(t)
g = 0.5 * (1 - cos(2 * pi * t / T)) .* (t >= 0 & t <= T);

% Calculate 128 point DFT using FFT
G = fft(g, N);
G_sq_mag = abs(G).^2;  % Square magnitude of DFT

% Define the correlation function R_a(m)
R_a = zeros(1, N);
R_a(1) = 1;           % R_a(0)
R_a(2) = 1/2;        % R_a(1)
R_a(N-1) = 1/2;      % R_a(-1)

% Compute the Power Spectrum S_v(f) by taking FFT of R_a
S_v = fft(R_a, N);

% Frequency vector (adjusted to match size of S_v)
f = (0:N-1) * (1/(N * (10)));  % Sampling frequency is 1/10
```

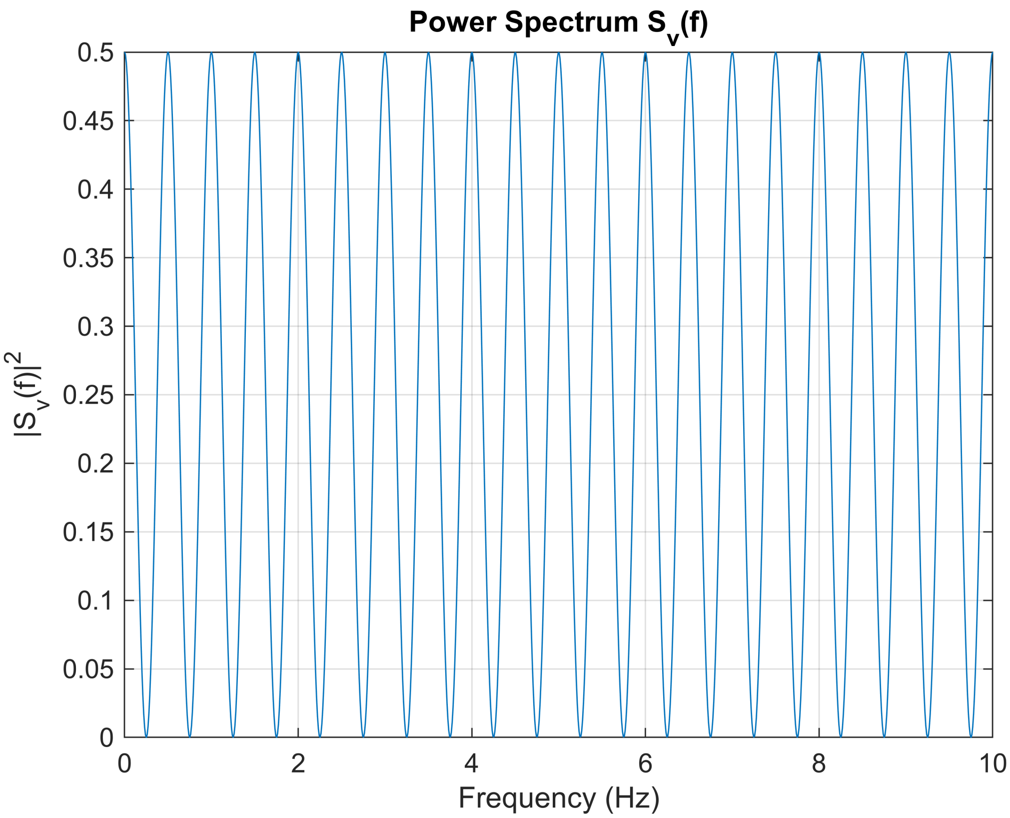
```
% Plot the Power Spectrum S_v(f)
figure;
plot(f, abs(S_v).^2);
title('Power Spectrum S_v(f)');
xlabel('Frequency (Hz)');
ylabel('S_v(f)');
grid on;
```




```
% Plot DFT Square Magnitude
figure;
stem(0:N-1, G_sq_mag, 'filled');
title('DFT Square Magnitude |G_m|^2');
xlabel('m (DFT Index)');
ylabel('|G_m|^2');
grid on;
```




```
T = 1; % Pulse duration
t = linspace(0, T, 1000); % Time vector for simulation
N = 100;
g_t = @(t) (1 - cos(2*pi*t/T)) / T .* (t >= 0 & t <= T); % g(t) definition

a_n = zeros(N, 1); % Initialize a_n
frequencies = linspace(0, 10, 1000);
R_a = zeros(size(frequencies)); % Initialize R_a as a vector

for n = 1:N
    a_n(n) = sqrt(2/T) * integral(@(t) g_t(t) .* cos(2*pi*n*t/T), 0, T);
    R_a = R_a + a_n(n) * cos(2*pi*n*frequencies/T);
end

S_v = abs(R_a) .^ 2; % Compute the power spectrum

% Plot the power spectrum
figure;
plot(frequencies, S_v);
title('Power Spectrum S_v(f)');
xlabel('Frequency (Hz)');
ylabel('|S_v(f)|^2');
grid on;
```


Power Spectrum S_v(f)
|S_v(f)|^2
Frequency (Hz)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2
4
6
8
10