
Solutions to PS # 5.0
Signal Processing Using MATLAB
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Frequency Based Coding

```
%*****
% This MATLAB function generates a frequency coded
% signal in response to a digit code entered
% AUTHOR: Balu Santhanam
% DATE : 04/03/01
% USAGE
% [s,freq] = freq_code(digits,T_d,f_s)
% s      : frequency coded output
% freq   : IF signal
% digits : sequence of 5 digits entered by user
% T_d    : Duration of each digit in sec
% f_s    : Sampling frequency in Hz
%*****
function [s,freq] = freq_code(digits,T_d,f_s)
% Error control
if nargin ~= 3
    error('Insufficient input')
elseif length(find(mod(digits,1)~= 0))~= 0
    error('Digits entered have to be integers')
elseif length(digits)~= 5
    error('Please enter 5 digits again')
elseif length(find(digits > 4))~=0 | length(find(digits < 0))~=0
    error('digits have to be 0-4')
elseif isnumeric([digits,T_d,f_s]) ~= 1
    error('Non numeric input')
end
N = round(f_s*T_d);
freq = pi/2 + (pi/200)*kron(digits,ones(1,N));
s = cos(cumsum(freq));
return
%*****
```

Hilbert Transform Decoding

```
*****
% MATLAB function for decoding a frequency-coded signal
% using Hilbert transform demodulation
% AUTHOR : Balu Santhanam
% DATE   : 04/03/01
% USAGE :
% [digit,IF] = freqdec(s,T_d,f_s)
% digit : Estimate of dialed digits
% IF     : IF estimate
*****
function [digit,IF] = freqdec(s,T_d,f_s)
if nargin ~= 3
    error('Insufficient input')
elseif isnumeric([T_d,f_s]) ~= 1
    error('Non numeric input')
end
N = round(f_s*T_d);
phi = unwrap(angle(hilbert(s)));
omega_hat = diff(phi);
IF = omega_hat;
omega_c = [mean(omega_hat(26:N)), mean(omega_hat(N+1:2*N)),...
mean(omega_hat(2*N+1:3*N)), mean(omega_hat(3*N+1:4*N)),...
mean(omega_hat(4*N+1:length(omega_hat)))]];
digit = round((omega_c - pi/2)/(pi/200));
return
*****
```