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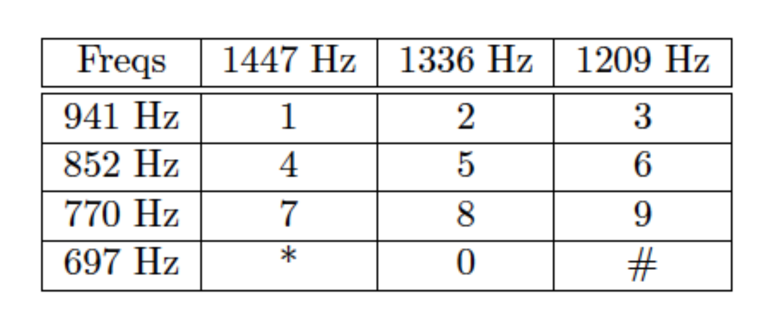
TTT4110 PROJECT WORK

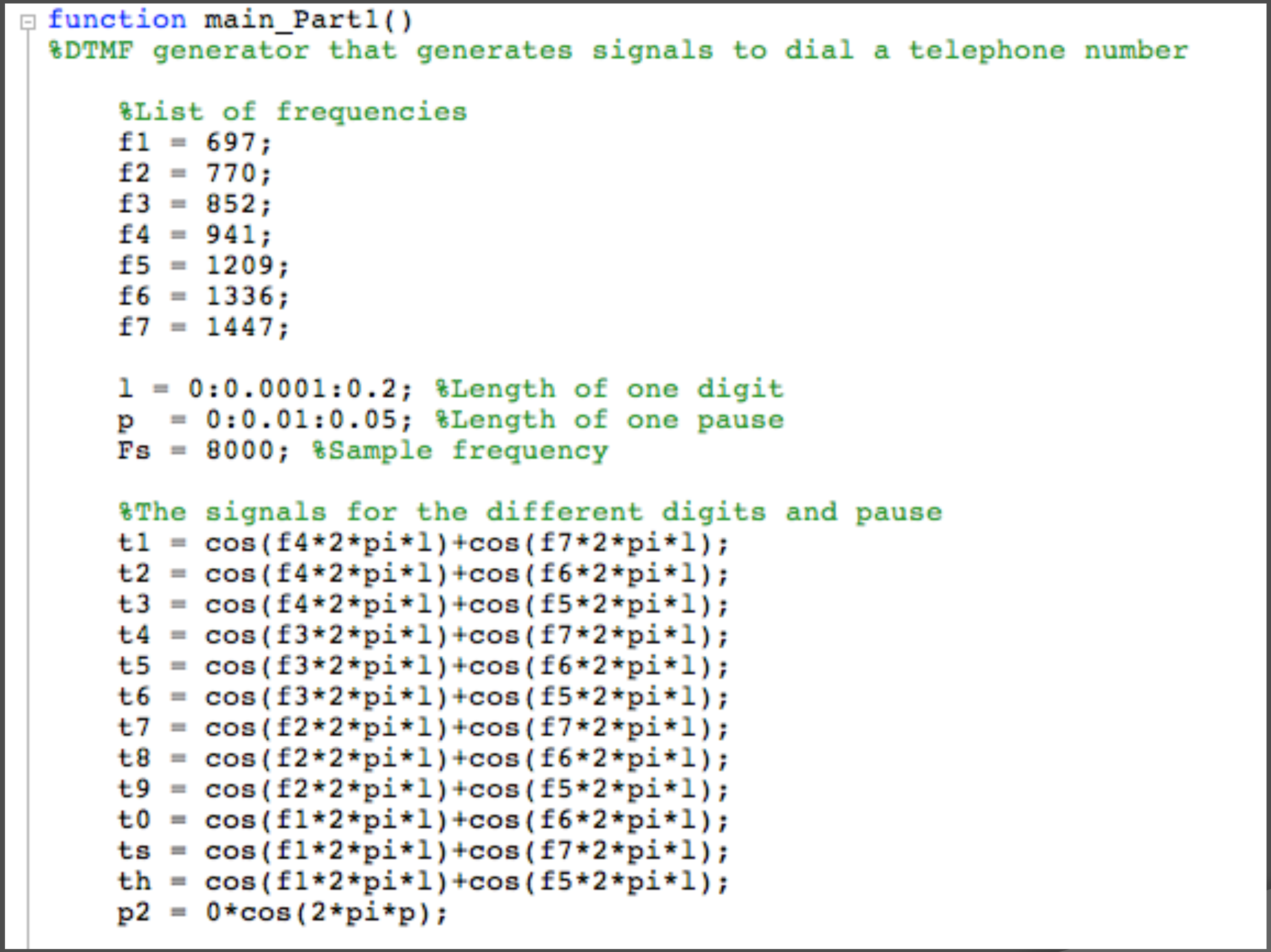
Part1: Touch-Tone Dialing

- Generate Dual-Tone Multi-Frequency signals
- Play the generates signals



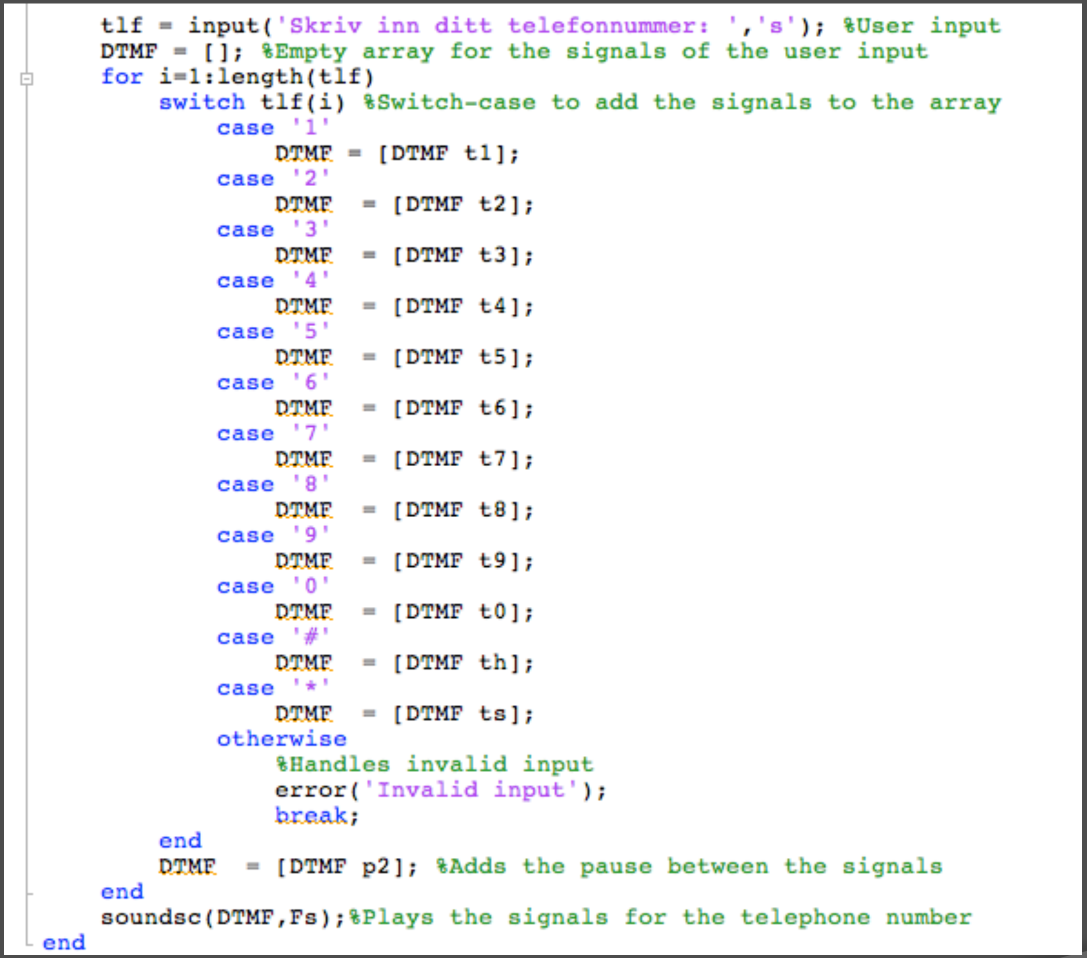
Freqs	1447 Hz	1336 Hz	1209 Hz
941 Hz	1	2	3
852 Hz	4	5	6
770 Hz	7	8	9
697 Hz	*	0	#

main_Part1()



```
function main_Part1()
%DTMF generator that generates signals to dial a telephone number

    %List of frequencies
    f1 = 697;
    f2 = 770;
    f3 = 852;
    f4 = 941;
    f5 = 1209;
    f6 = 1336;
    f7 = 1447;

    l = 0:0.0001:0.2; %Length of one digit
    p  = 0:0.01:0.05; %Length of one pause
    Fs = 8000; %Sample frequency

    %The signals for the different digits and pause
    t1 = cos(f4*2*pi*l)+cos(f7*2*pi*l);
    t2 = cos(f4*2*pi*l)+cos(f6*2*pi*l);
    t3 = cos(f4*2*pi*l)+cos(f5*2*pi*l);
    t4 = cos(f3*2*pi*l)+cos(f7*2*pi*l);
    t5 = cos(f3*2*pi*l)+cos(f6*2*pi*l);
    t6 = cos(f3*2*pi*l)+cos(f5*2*pi*l);
    t7 = cos(f2*2*pi*l)+cos(f7*2*pi*l);
    t8 = cos(f2*2*pi*l)+cos(f6*2*pi*l);
    t9 = cos(f2*2*pi*l)+cos(f5*2*pi*l);
    t0 = cos(f1*2*pi*l)+cos(f6*2*pi*l);
    ts = cos(f1*2*pi*l)+cos(f7*2*pi*l);
    th = cos(f1*2*pi*l)+cos(f5*2*pi*l);
    p2 = 0*cos(2*pi*p);
```

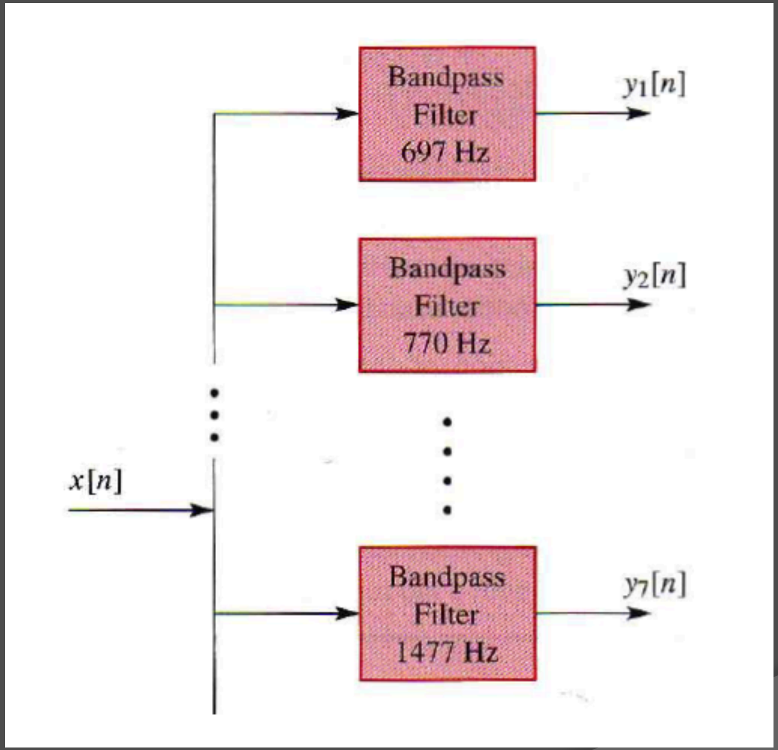
main_Part1() - continues



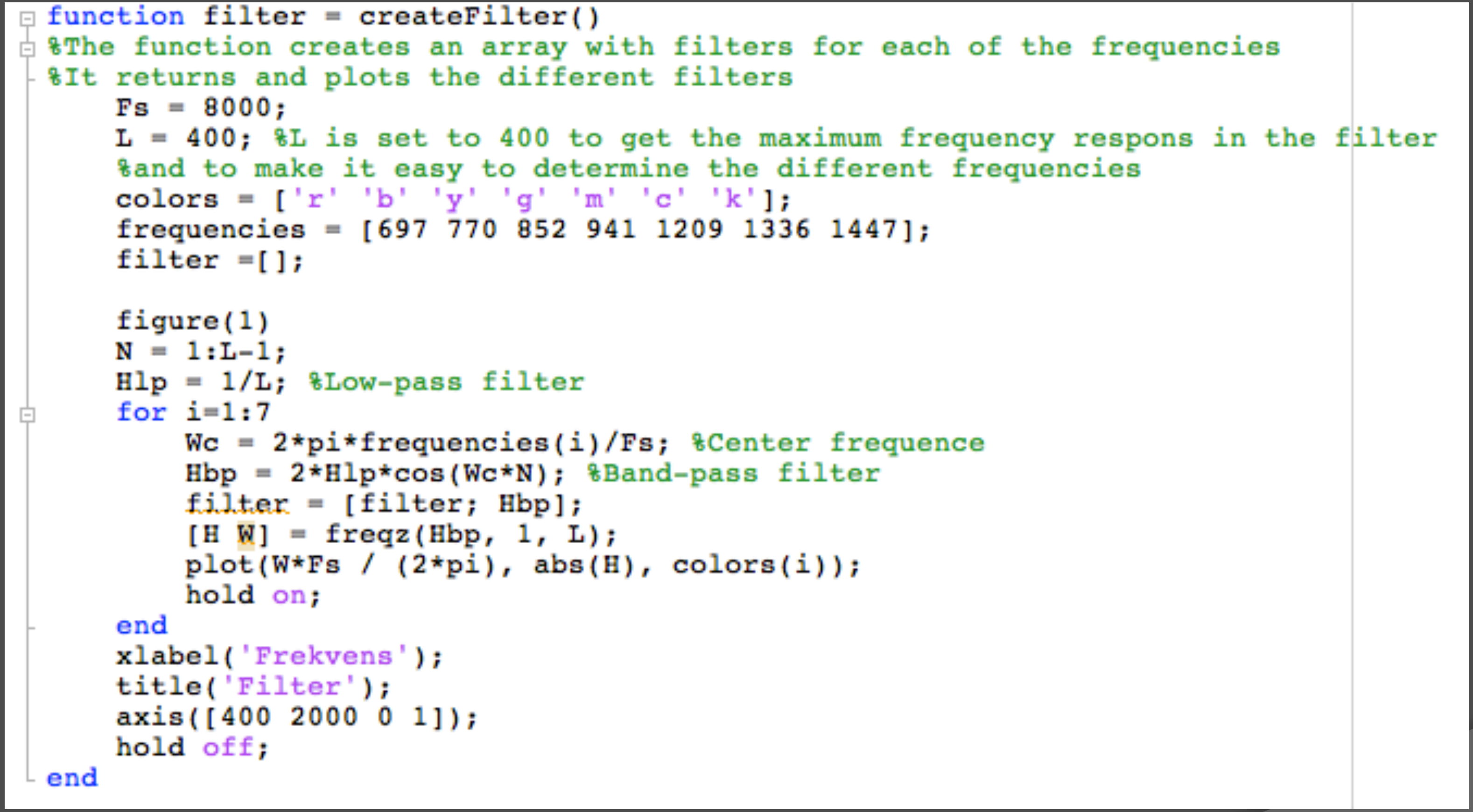
```
    tlf = input('Skriv inn ditt telefonnummer: ','s'); %User input
    DTMF = []; %Empty array for the signals of the user input
    for i=1:length(tlf)
        switch tlf(i) %Switch-case to add the signals to the array
            case '1'
                DTMF = [DTMF t1];
            case '2'
                DTMF  = [DTMF t2];
            case '3'
                DTMF  = [DTMF t3];
            case '4'
                DTMF  = [DTMF t4];
            case '5'
                DTMF  = [DTMF t5];
            case '6'
                DTMF  = [DTMF t6];
            case '7'
                DTMF  = [DTMF t7];
            case '8'
                DTMF  = [DTMF t8];
            case '9'
                DTMF  = [DTMF t9];
            case '0'
                DTMF  = [DTMF t0];
            case '#'
                DTMF  = [DTMF th];
            case '*'
                DTMF  = [DTMF ts];
            otherwise
                %Handles invalid input
                error('Invalid input');
                break;
        end
        DTMF  = [DTMF p2]; %Adds the pause between the signals
    end
    soundsc(DTMF,Fs);%Plays the signals for the telephone number
end
```

Part 2: DTMF Decoding

- Input: DTMF array
- Output: Telephone number
- createFilter()
- createNumber()
- Main_Part2(Sound)

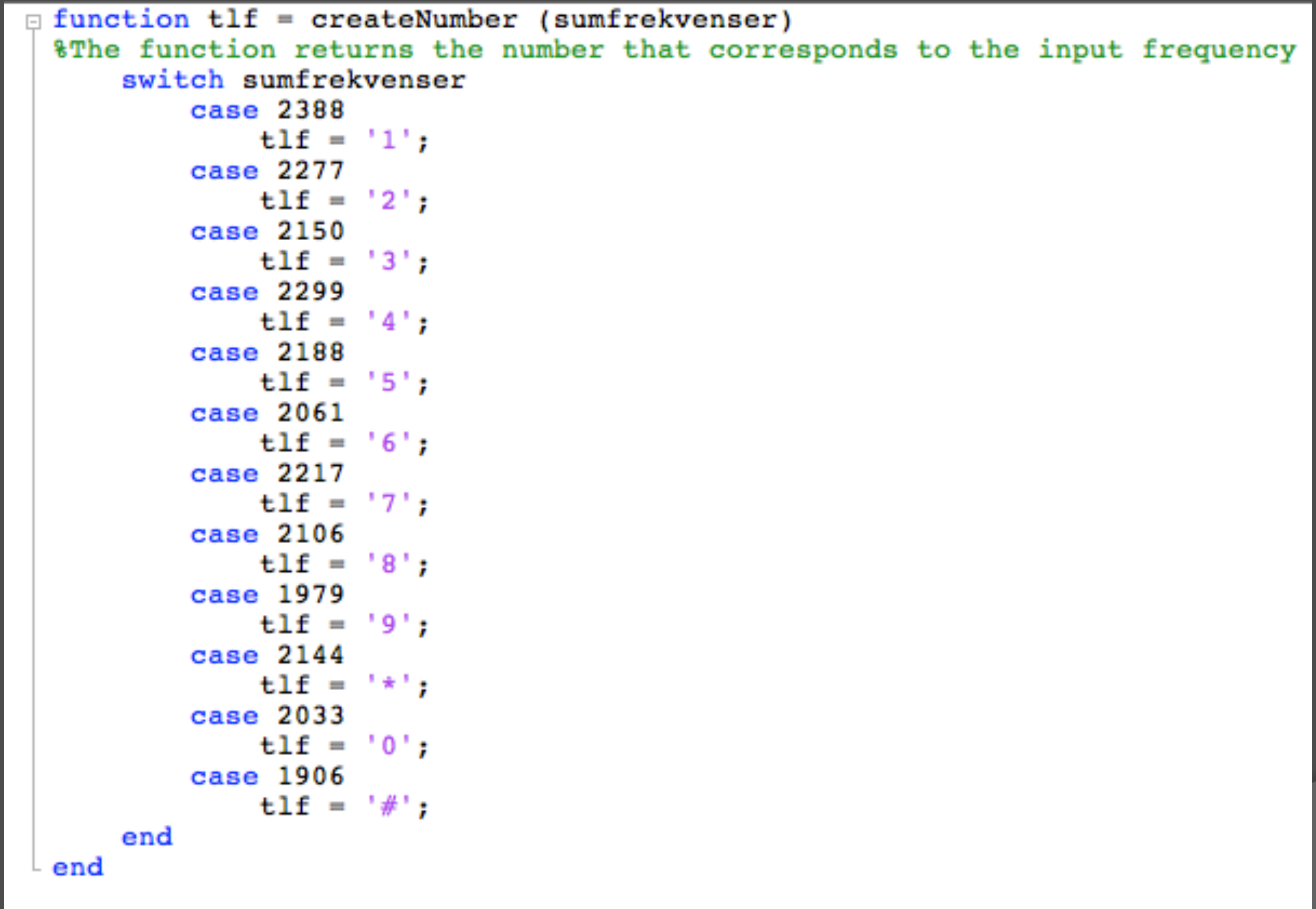


createFilter()



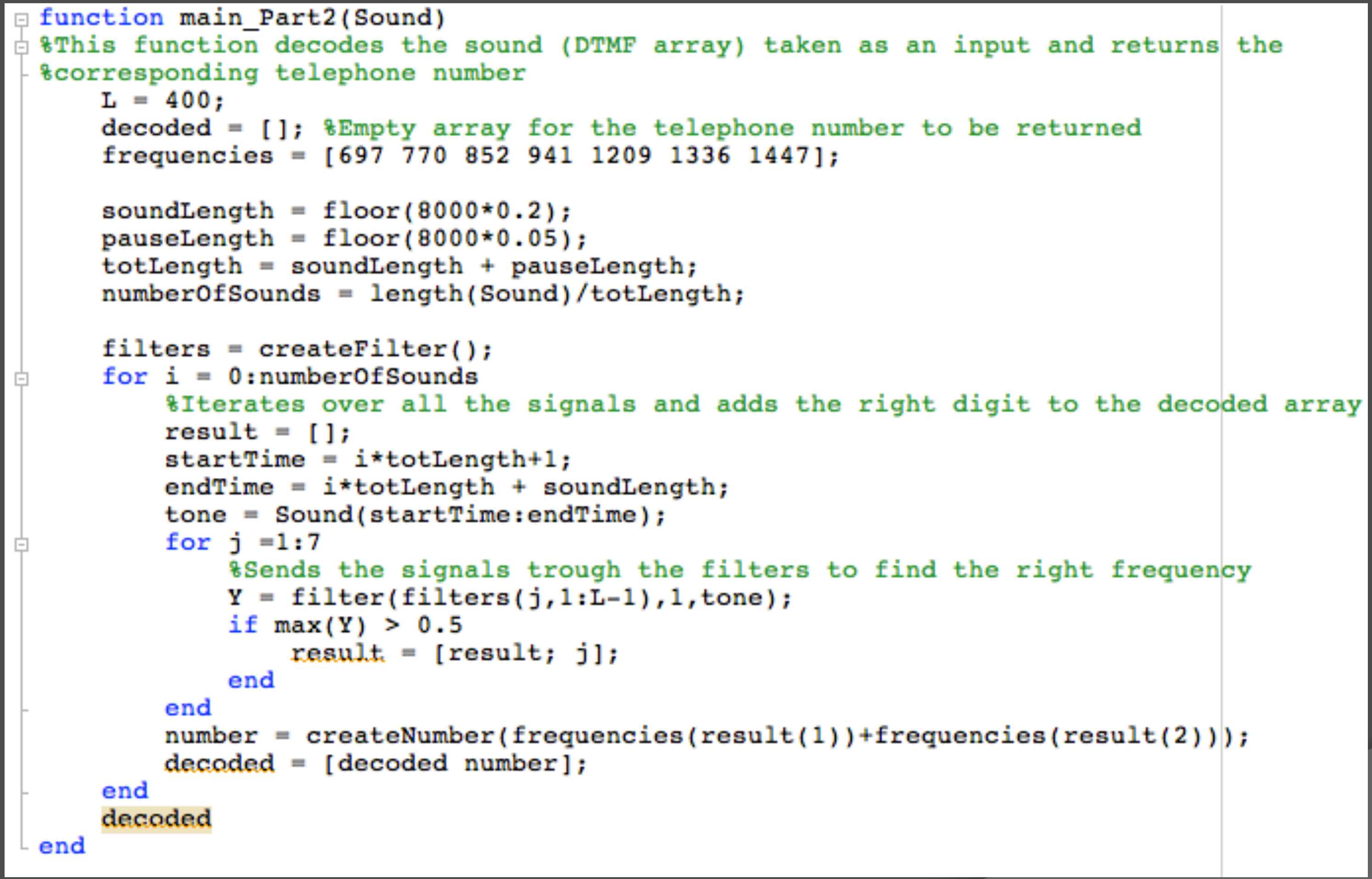
```
function filter = createFilter()
%The function creates an array with filters for each of the frequencies
%It returns and plots the different filters
    Fs = 8000;
    L = 400; %L is set to 400 to get the maximum frequency respons in the filter
    %and to make it easy to determine the different frequencies
    colors = ['r' 'b' 'y' 'g' 'm' 'c' 'k'];
    frequencies = [697 770 852 941 1209 1336 1447];
    filter =[];

    figure(1)
    N = 1:L-1;
    Hlp = 1/L; %Low-pass filter
    for i=1:7
        Wc = 2*pi*frequencies(i)/Fs; %Center frequence
        Hbp = 2*Hlp*cos(Wc*N); %Band-pass filter
        filter = [filter; Hbp];
        [H W] = freqz(Hbp, 1, L);
        plot(W*Fs / (2*pi), abs(H), colors(i));
        hold on;
    end
    xlabel('Frekvens');
    title('Filter');
    axis([400 2000 0 1]);
    hold off;
end
```

createNumber()



```
function tlf = createNumber (sumfrekvenser)
%The function returns the number that corresponds to the input frequency
    switch sumfrekvenser
        case 2388
            tlf = '1';
        case 2277
            tlf = '2';
        case 2150
            tlf = '3';
        case 2299
            tlf = '4';
        case 2188
            tlf = '5';
        case 2061
            tlf = '6';
        case 2217
            tlf = '7';
        case 2106
            tlf = '8';
        case 1979
            tlf = '9';
        case 2144
            tlf = '*';
        case 2033
            tlf = '0';
        case 1906
            tlf = '#';
    end
end
```

main_Part2(Sound)



```
function main_Part2(Sound)
%This function decodes the sound (DTMF array) taken as an input and returns the
%corresponding telephone number
    L = 400;
    decoded = []; %Empty array for the telephone number to be returned
    frequencies = [697 770 852 941 1209 1336 1447];

    soundLength = floor(8000*0.2);
    pauseLength = floor(8000*0.05);
    totLength = soundLength + pauseLength;
    numberOfSounds = length(Sound)/totLength;

    filters = createFilter();
    for i = 0:numberOfSounds
        %Iterates over all the signals and adds the right digit to the decoded array
        result = [];
        startTime = i*totLength+1;
        endTime = i*totLength + soundLength;
        tone = Sound(startTime:endTime);
        for j =1:7
            %Sends the signals trough the filters to find the right frequency
            Y = filter(filters(j,1:L-1),1,tone);
            if max(Y) > 0.5
                result = [result; j];
            end
        end
        number = createNumber(frequencies(result(1))+frequencies(result(2)));
        decoded = [decoded number];
    end
    decoded
end
```

Tusen takk!

THANK YOU!