



Faculty of Electrical & Electronics Engineering

DIGITAL SIGNAL PROCESSING

CHAPTER 6: IIR FILTER DESIGN

PROJECT / ASSIGNMENT (50 Marks)

Name: _____

Date: _____

Project/Assignment Instructions:

- (i) This is a group project.
- (ii) Deadline (Due date): **will be determined.**
- (iii) Submission method: Hardcopy report and softcopy of the MATLAB coding. The hardcopy format shall follow the standard report format. All group members must sign the cover sheet of the report.
- (iv) The coverage of the project is teaching materials/slides on the related topics slides and reference books as stated below;
 - 1. J.G. Proakis and M.G Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*, New Jersey, USA: Prentice Hall, 1996 (Chapter 7 & 8).
 - 2. S.K. Mitra, *Digital Signal Processing: A Computer-Based Approach*, 3rd Ed., New York, USA: McGraw-Hill, 2006 (Chapter 8-10)
 - 3. E. C. Ifeachor & B. W. Jarvis, *Digital Signal Processing: A Practical Approach*, 2nd Ed., Essex, England: Prentice Hall, 2002 (Chapter 6, 7, 8).
 - 4. R. J. Thervo, *Practical Signals Theory with MATLAB Applications*, USA: Wiley & Sons, 2010 (Chapter 9).
 - 5. A. Palamides & A. Veloni, *Signals and Systems Laboratory with MATLAB*, USA: CRC Press, 2011 (Chapter 8, Chapter 11).The other Digital Signal Processing reference books can be referred as well including engineering letter, magazine or website.
- (v) Software: MATLAB.
- (vi) The project requires presentation from each group.

Project/Assignment Background:

A digital filter is the basic building block in any Digital Signal Processing (DSP) system. It is used to filter the source signals to the specified frequencies for the process of DTS (discrete-time systems). The **frequency response** of the filter depends on the value of filter coefficients which can be obtained from the filter specifications. The quality of the filtered signal depends on the **filter coefficients**. Many software or application programs are available to compute the values of coefficients based on the desired frequency response. In this course, students are exposed to computer-aided digital filter design using MATLAB.

Project/Assignment Task:

Tasks 1 (IIR Filter):

As an Electronics Engineer, you are required to design the suitable IIR filter to remove the baseline wander and artefacts due to the body movement in a certain biomedical application. The filter is required to meet the following requirements;

- Passband frequency : 1 – 30 Hz
 - Stopband frequency: 0 – 0.5 Hz and 40 – 128 Hz.
 - Stop attenuation : ≥ 30 dB
 - Passband ripple : ≤ 0.1 dB
 - Sampling frequency : 256 Hz
- (i) Select the suitable IIR filter type, calculate and then construct MATLAB program to determine the **filter order/length, filter coefficients, filter responses, and transfer function and the poles of the filter.**
- (ii) Use MATLAB program to obtain the **pole-zero diagram** of the transfer function of the system.

Tasks 2 (Filter Conversion):

An analog filter is to be converted into equivalent digital filter that will operate at a sampling frequency of 500 Hz. The analog filter has the following specifications.

$$H(s) = 1 / (3s^3 + 6s^2 + 2s + 1)$$

- (i) Obtain the digital filter, $H(z)$ using both Bilinear Transformation and Impulse Invariant method.
- (ii) Use MATLAB to find the suitable filter coefficients for the digital filter, $H(z)$.
- (iii) Find the **difference equation** of the system.

