1 Objectives/Outcome:

It is important to understand that impulse response is the key for any system to have a desired output. Thus, designing a system for a desired output means determining the impulse response $H(z)/H(\omega)$ in frequency domain ($H(z)$ considering that the system is discrete time domain). The objective of this session is to design IIR filter using the following main steps:

1) Design the filter using Analog filters Butterworth/Chebyshev to get H(s)
2) Map the Analog filter specs to digital filter design using Impulse Invariance ***impinvar()***

2 Tasks

2.1 Design of LPF using IIR filters

Digital Low pass digital filter using Impulse Invariance to satisfy the following:

1) Monotonic stop band and passband
2) -1dB cut off frequency of 0.2πradians
3) Magnitude of at-least 15dB at 0.35πradians

Validate the design of the filter by generating samples of sinusoids of different frequency and cross verifying the output using one of the below techniques. Validate the cut off frequency corresponding to -3dB gain.

a) Filter function, filter()
b) Convolution in frequency domain or time domain.

Steps:

1) Use buttord() and butter() to evaluate order and analogue filter transfer function
2) Use impinvar() to convert the analogue filter to digital filter

2.2 Design of LPF Chebyshev using IIR filter

Same as 2.2 but use Chebyshev filter.

2.3 Design of HPF, BPF, BPS using Butterworth

Using Butterworth determine the co-efficient in s domain and plot them given pass band, stop band frequencies with the gains corresponding to the bands.

1) HPF

```
fr = 600;
fp = 800;
wr=2*pi*fr;
wp=2*pi*fp;
```

```
K1=3;
K2=20;
```

2) BPF

```
fr = [600 1200];
fp = [800 1000];
wr=2*pi*fr;
wp=2*pi*fp;
K1=3;
K2=20;
```

3) BSF

```
fp = [600 1200];
fr = [800 1000];
wr=2*pi*fr;
wp=2*pi*fp;
K1=3;
K2=20;
```