Tutorial Questions:
Introduction to IIR Filters

1. How is a recursive digital filter different from a non-recursive digital filter? Explain in a few sentences and draw two example system diagrams, one of a recursive filter and one of non-recursive filter.

2. Design a bandpass filter using the pole-zero placement method with:
   - centre frequency $\Omega_0 = \pi/2$
   - bandwidth $\Omega_{bw} = \pi/8$
   - complete attenuation at $\Omega_{r1} = 0$ and $\Omega_{r2} = \pi$

3. Calculate the difference equation for the above system.

4. Calculate and sketch the frequency response for the above filter from the z-plane representation.

5. For the above system, with sampling frequency $500Hz$:
   (a) What is the bandpass centre frequency?

   (b) The bandwidth?

6. Design a digital bandstop filter using pole-zero placement method with following parameters:
   - Centre frequency $\Omega_0 = \pi/10$ radians (complete attenuation)
   - Bandstop width, $\Omega_w = 2\Omega_{\text{cf}} = \pi/20$ radians

7. Convert the following single pole low pass analog filter into a digital filter (z-plane form transfer function) with digital cut-off frequency $\Omega_{\text{cf}} = 0.3\pi$ using the bilinear transformation method:

$$H(s) = \frac{\omega_{\text{cf}}}{s + \omega_{\text{cf}}}.$$

8. Is the digital filter for the above stable?

9. Calculate the time domain difference equation from the z-plane representation of the transfer function.

10. Calculate and sketch the magnitude frequency response for the above filter, using the bilinear transformation method.

11. List the advantages and disadvantages of recursive filters in comparison to non-recursive filters.