Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FOURTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
AUGUST 2021
SUBJECT: DIGITAL SIGNAL PROCESSING (ECE - 2255)

TIME: 2 HOURS **MAX. MARKS: 40**

Instructions to candidates
- Answer **any four full** questions.
- Missing data may be suitably assumed.

1A. It is required to design a causal discrete LTI system such that it produces an output $y[n] = \left(\frac{1}{3}\right)^n u[n]$ when the input $x[n] = \left(\frac{1}{2}\right)^n \left\{u[n] - \frac{1}{2}u[n-1]\right\}$
  i. Determine impulse response h(n) and system function H(z)
  ii. Determine difference equation.
  iii. Is the system stable? If so, identify and sketch the ROC of H(z)

1B. With example explain the concept of circular shift of a sequence. Determine 8-point circular convolution between the signals $x_1[n]$ = [1 2 3 1] and $x_2[n]$ = [4 3 2 1] using DFT/IDFT calculations.

(5+5)

2A. Using radix-2 DIF algorithm, determine 8-point inverse DFT of X[k]= [0 4 0 0 0 0 0 4]. Clearly indicate the values at every node of the flow diagram.

2B. Derive Goertzel algorithm for the computation of N-point DFT of a signal. Determine the system function H(z) and difference equation for the system that uses Geortzel algorithm to compute DFT value $X(-k)_N$ for the real valued signal x(n).

(5+5)

3A. Obtain and sketch the direct form I, direct form II and cascade structures for the IIR system $H(z) = \frac{2(z-1)(z^2+\sqrt{2}\,z+1)}{(z+0.5)(z^2-0.9z+0.81)}$
Second order sections are allowed in cascade structure.

3B. Consider an FIR system having impulse response h(n) = δ(n)+ δ(n-1)+ 0.5δ(n-2)+ δ(n-3)+ δ(n-4). Realize the system using frequency sampling structure.

(5+5)

4A. With relevant mathematical analysis explain the design of IIR filters by the bilinear transformation. Describe why pre-warping is necessary when using bilinear transformation.

4B. Determine the poles and transfer function H(s) for the third order analog Butterworth prototype (cut-off frequency=1 rad/sec) filter. Digitize this using impulse invariance transformation with T=0.1sec and obtain the system function H(z).

(5+5)

5A. Illustrate with diagram the frequency response of Chebyshev type-I LPF. Compute the minimum order and analog transfer function H(s) of such filter, where the maximum allowable ripple is 1dB in the pass-band extending from 0 to 0.1π radians/sec. The minimum attenuation should be 40dB at the stop-band edge frequency of 0.3π radians/sec.

5B. Design digital IIR notch filter to suppress 50 Hz interference. The filter should work at a sampling frequency of 500 Hz. The notch bandwidth should be 5Hz. Assume $b_0=1$. Write down the corresponding frequency response.

(5+5)

6A. Describe the time domain and frequency domain characteristics of linear phase FIR filters. Obtain an expression for system function H(z) of even length symmetric linear phase FIR filter in terms of (M-1)/2 coefficients where M is the length of the filter. Sketch the tapped delay line realization for the same.

6B. Determine coefficients of 9 length symmetric digital FIR high pass filter using causal hamming window. The filter has desirable pass band extending from 400 Hz to 1000 Hz at a sampling frequency of 2000 Hz. The filter should have precisely linear phase response in the pass band. Obtain the frequency response of this filter.

(5+5)