(b) Determine the system function $H(z)$ of the lowest order chebyshev and butterworth digital filter with the following specifications. (15)

(i) 3dB ripple in the passband $0 \le w \le 0.2\pi$

(ii) 25dB attenuation in the stop band $0.45\pi \le w \le \pi$. Use the bilinear transformation.

Reg. No. : [ ]

Question Paper Code : 20418

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fifth Semester

Electronics and Communication Engineering

EC 6502 — PRINCIPLES OF DIGITAL SIGNAL PROCESSING

(Common to Biomedical Engineering/Medical Electronics)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How many multiplications and additions are required to compute N point DFT using redix-2 FFT?

2. Why the computations in FFT algorithm is said to be in place?

3. State the structure of IIR filter?

4. What are the properties of bilinear transformation?

5. Determine the coefficients $\{h(n)\}$ of a linear-phase FIR filter of length M = 15 which has a symmetric unit sample response and a frequency response that satisfies the condition $H_r = \left(\frac{2\pi k}{15}\right) = \begin{cases}1, & k = 0, 1, 2, 3\\ 0, & k = 4, 5, 6, 7\end{cases}$

6. What is the necessary and sufficient condition for linear phase characteristic in FIR filter?

7. What is product quantization error?

8. What is meant by floating point representation?

9. Define decimation.

10. What is multirate signal processing and what are its advantages?

PART B — (5 × 13 = 65 marks)

11. (a) Let $x_p(n)$ be a periodic sequence with fundamental period N. Consider the following DFTs : (13)

$x_p(n) \xleftrightarrow[N]{DFT} x_1(k)$

$x_p(n) \xleftrightarrow[3N]{DFT} x_3(k)$

(i) What is the relationship between $x_1(k)$ and $x_3(k)$?

(ii) Verify the result in part (i) using the sequence

$x_p(n) = \{...1, 2, 1, \underset{\uparrow}{2}, 1, 2, 1, 2...\}$

Or

(b) Consider the length-8 sequence defined for $0 \le n \le 8$

$x(n) = \{1, 2, -3, 0, 1, -1, 4, 2\}$

with a 8-point DFT. Evaluate the following functions of $X(k)$ without computing DFT. (i) $X(0)$ (ii) $X(4)$ (iii) $\sum_{k=0}^{7} X(k)$ (iv) $\sum_{k=0}^{7} e^{-j\frac{3\pi}{4}} X(k)$ (v) $\sum_{k=0}^{7} |X(k)|^2$. (13)

12. (a) Given the specifications $\alpha_p = 3\text{dB}; \alpha_s = 16\text{dB}; f_p = 1\text{KHz}$ and $f_s = 2\text{KHz}$. Determine the order of the filter using Chebyshev approximation. Find H(s). (13)

Or

(b) Using the bilinear transform, design a high pass filter, monotonic in pass band with cutoff frequency of 1000Hz and down 10dB at 350Hz. The sampling frequency is 5000Hz. (13)

13. (a) Design an FIR low pass filter satisfying the following specifications $\alpha_p \le 0.1\text{dB}\, \alpha_s \ge 44.0\text{dB}\ \omega_p = 20$ rad/sec $\omega_s = 30$ rad/sec $\omega_{sf} = 100$ rad/sec. (13)

Or

(b) Using a rectangular window technique design a lowpass filter with pass band gain of unity, cutoff frequency of 1000Hz and working at a sampling frequency of 5KHz. The length of the impulse response should be 7. (13)

14. (a) Explain the characteristics of a limit cycle oscillation with respect to the system described by the difference equation $y(n) = 0.95y(n-1) + x(n)$. Determine the dead band of the filter. (13)

Or

(b) (i) The input to the system $y(n) = 0.999y(n-1) + x(n)$ is applied to an ADC. What is the power produced by the quantization noise at the output of the filter if the input is quantized to a (1) 8 bits (2) 16 bits. (6)

(ii) Consider the recursive filter $y(n) = 0.8y(n-1) + x(n)$. The input $x(n)$ has a range of values of $\pm 100v$, represented by 8 bits. Compute the variance of output due to A/D conversion process. (7)

15. (a) Derive the spectrum of the down sampled signal. Explain aliasing effect and how it can be avoided? (13)

Or

(b) Show that the up-sampler and down-sampler linear time variant systems. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Determine the coefficients of a linear phase FIR filter of length M = 15 which has a symmetric unit sample response and a frequency response that satisfies the conditions. (15)

$H_r\left(\frac{2\pi k}{15}\right) = \{1 \text{ for } k = 0, 1, 2, 3$

$H_r\left(\frac{2\pi k}{15}\right) = \{0.4 \text{ for } k = 4$

$H_r\left(\frac{2\pi k}{15}\right) = \{0 \text{ for } k = 5, 6, 7$

Or