Reg. No. : E N G G T R E E . C O M

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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Electronics and Communication Engineering

EC 3492 — DIGITAL SIGNAL PROCESSING

(Common to Electronics and Telecommunication Engineering/Medical Electronics)

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — $(10 \times 2 = 20$ marks)

1. Find the twiddle factors for an eight-point DFT.

2. Write the relationship between circular correlation in the time domain and frequency domain.

3. What are the important features of the IIR filters?

4. How are analog poles mapped to digital poles in the impulse invariant transformation?

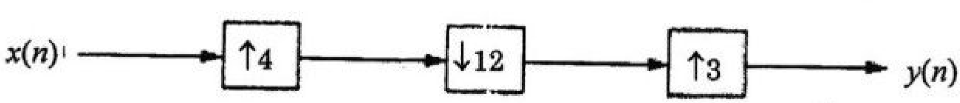
5. Mention the design techniques for FIR filters.

6. What are the possible types of the impulse response for linear phase FIR filters?

7. Convert the number $(0.93)_{10}$ into binary notation having five bits, including the sign bit.

8. What is the effect of Quantization?

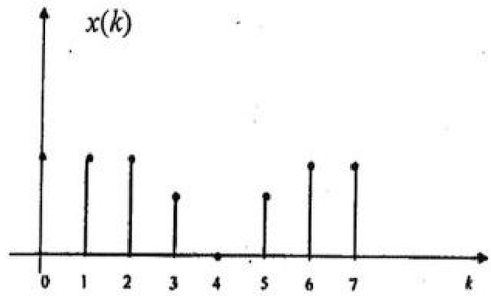
9. For the multi-rate system shown in the Figure below, develop an expression for the output $y(n)$ as a function of the input $x(n)$.



10. What is the use of a TDM serial port?

PART B — (5 × 13 = 65 marks)

11. (a) (i) A finite duration sequence $x(n)$ of length eight has the DFT X (k), as shown in the figure below



A new sequence $y(n)$ of length 16 is defined by :

$$y(n) = x\left(\frac{n}{2}\right) \quad \text{for n = even}$$

$$= 0 \quad \text{for n = odd}$$

Sketch the DFT $Y(k)$ as a function of 'k'. (6)

(ii) Find the four-point FFT of $x(n)=\{1, 0,1,1\}$ using the decimation-in-time algorithm. (7)

Or

(b) (i) Find the circular convolution of the three-point sequences $x(n)=\{1,3,-4\}$, and $h(n)=\{-2,1,2\}$. (6)

(ii) Find the eight-point IDFT using the DIT algorithm for the following input.

$X(k) = \{20, -5.828-j2.279, 0, -0.172-j0.279,$
$0, -0.172+j0.279, 0, -5.828+j2.279\}$. (7)

12. (a) Design a Butterworth filter using the impulse-invariant method for the following specifications : (13)

$0.8 \le \left|H\left(e^{j\omega}\right)\right| \le 1 \qquad 0 \le \omega \le 0.2\pi$

$\left|H\left(e^{j\omega}\right)\right| \le 0.2 \qquad 0.6\pi \le \omega \le \pi$

Or

(b) Design a lowpass Butterworth IIR filter for the following specifications :

Passband edge frequency: 1000 Hz

Stopband edge frequency: 3000 Hz

Passband ripple: 2 dB

Stopband ripple: 20 dB

Assume a sampling frequency is 8KHz and use the bilinear transformation. (13)

13. (a) The desired impulse response of a certain FIR lowpass filter is given by

$$H(f)=1 \ \ for \ \ 0 \le f \le 1 \ kHz$$
$$= 0 \ \ for \ \ f > 1 \ kHz$$

For a sampling rate of 10 KHz and impulse response of 1 ms duration, compute the impulse response of the FIR filter. (13)

Or

(b) Design an FIR band-stop (band rejects or band elimination or notch) filter for the following specifications.

Cutoff frequencies = 400 Hz and 800 Hz

Sampling frequency = 2000 Hz

N = 11. (13)

14. (a) Consider the following transfer function.

$$H(z)=\frac{1}{(1-0.943z^{-1})(1-0.902z^{-1})} \text{ (cascade form)}$$
$$=\frac{1}{1-1.845\,z^{-1}+0.850586\,z^{-2}} \text{ (direct form)}$$

If the coefficients are quantized by truncation or rounding so that they can be expressed in six-bit binary form in which two bits are used to represent integers (including the sign bit) and four bits to represent fractions, find the pole positions for the cascade and direct forms with quantized coefficients. (13)

Or

(b) Determine the variance of the noise in the output due to the quantization of the input for the first-order filter.

$$y(n)=cy(n-1)+x(n),\ 0<|c|<1.$$ (13)

15. (a) Find the representation for the spectrum of a down-sampled signal. (13)

Or

(b) Explain the architecture of TMS320C50. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Design a high-pass filter using Hamming window, with a cutoff frequency of 1.2 rad/sec and N=9. (15)

Or

(b) (i) Realize an FIR system mentioned below :

$$y(n)+2y(n-1)+3y(n-2)=4x(n)+5x(n-1)+6x(n-2)$$

Using the transposed form structure. (7)

(ii) Find the output noise power in the direct form I and II realizations of the transfer function

$$H(z)=\frac{Y(z)}{X(z)}=\frac{0.6}{\left(1-0.9z^{-1}\right)\left(1-0.8z^{-1}\right)}.$$ (8)

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