

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)

$$x_p(n) \xrightarrow{\text{DFT}} x_1(k)$$

$$x_p(n) \xrightarrow{\text{DFT}} x_3(k)$$

- (i) What is the relationship between $x_1(k)$ and $x_3(k)$?
 (ii) Verify the result in part (i) using the sequence

$$x_p(n) = \{ \dots 1, 2, 1, 2, 1, 2, 1, 2, \dots \}$$

Or

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

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

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 $\alpha_p \leq 0.1\text{dB}$, $\alpha_s \geq 44.0\text{dB}$, $\omega_p = 20 \text{ rad/sec}$, $\omega_s = 30 \text{ rad/sec}$, $\omega_{sf} = 100 \text{ rad/sec}$. (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