SRM Institute of Science and Technology
Faculty of Engineering and Technology

SET-A

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

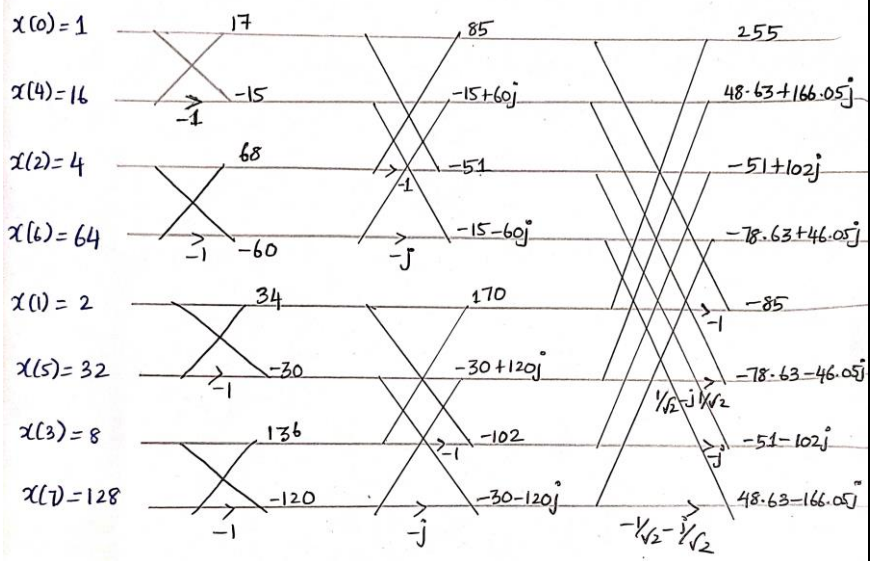
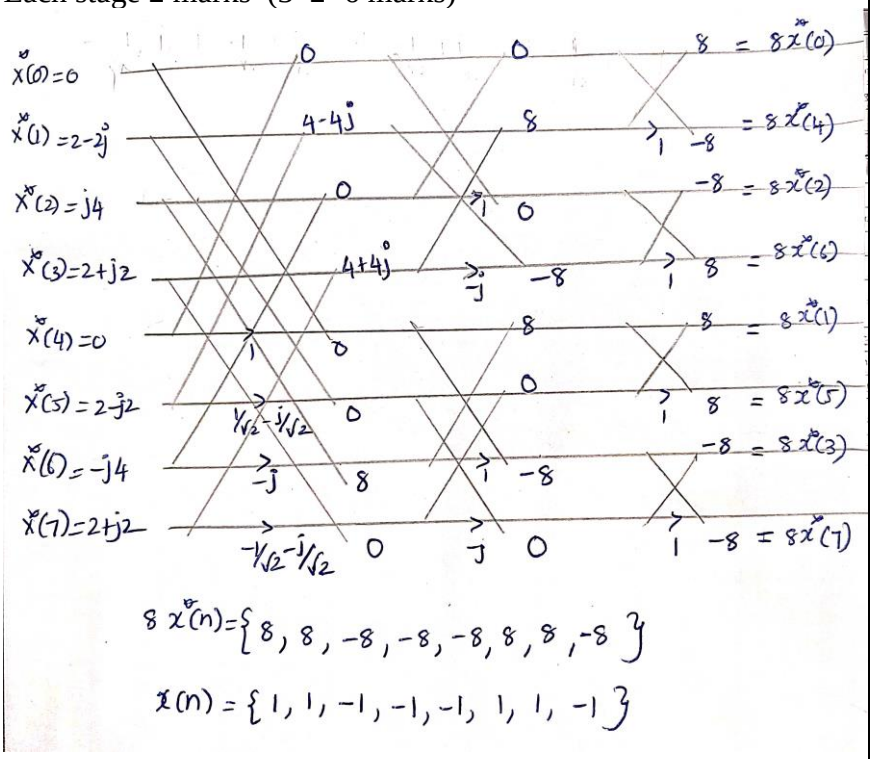
Academic Year: 2022-2023 (ODD)

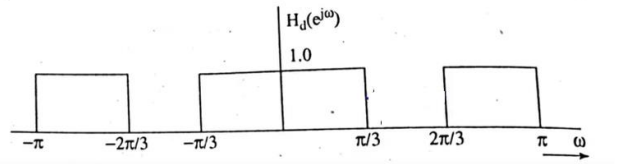
Test: CLAT-2 **Date: 17/10/22**
Course Code & Title: 18ECC204J-Digital Signal Processing **Duration: 12:30-2:15 PM**
Year & Sem: III /V **Max. Marks: 50**

Course Articulation Matrix: ***(to be placed)***

	18ECC204J – Digital Signal Processing	Program Outcomes (POs)														
		Graduate Attributes												PSO		
S. No.	Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	Summarize the concepts of A//D and D/A converters.	3	-	-	1	-	-	-	-	-	-	-	-	-	-	2
2	Explain the concepts of DFT with its efficient computation by using FFT algorithm.	-	2	-	-	-	-	-	-	-	-	-	-	-	1	
3	Develop FIR filters using several methods	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3
4	Construct IIR filters using several methods	-		3	-	-	-	-	-	-	-	-	-	-	-	3
5	Discuss the basics of multirate DSP and its applications.	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-
6	Design digital filter and multi rate signal processing for real time signals	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-

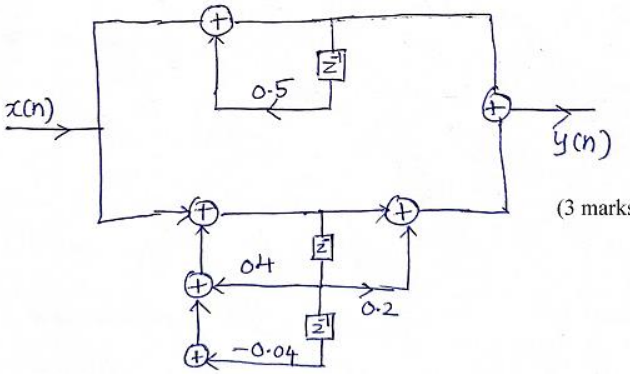
Q. No	Answer with choice variable	Marks	BL	CO	PO
1	i) y[n] = x[n] * h[n] y(n) = {1,3,7,13,14,14,8} (2 marks) z[n]= x[n] © h[n] z(n)={15,17,15,13} (2 marks) k=3 (1 mark)	5	4	2	2
	ii) Y[k] = X[k]·H[k]. Y[0] = 0, Y[1] = -6+12j, Y[2] = 0, Y[3] = -6-12j. (1 mark) The formula of of four-point IDFT $y[n]=\frac{1}{N}\sum_{k=0}^{3}Y[k]e^{j(2\pi/4)kn}$. y[0] = ¼ (0+(-6+12j)+0+(-6-12j)) = -3. y[1] = ¼ (0+(-6j-12)+0+(6j-12)) = -6. y[2] = ¼ (0+(6-12j)+0+(6+12j)) = 3. y[3] = ¼ (0+(6j+12)+0+(-6j+12)) = 6. (3 mark)	4	4	2	2
	iii) c) 3 x(0) = 1\6* (9 + 0j +2+j2+ 3-j0 +2-j2+1-j)= 3	1	2	2	1
2	i)	9	4	2	2

	$x(n) = 2^h = \{1, 2, 4, 8, 16, 32, 64, 128\}$  $X(k) = \{255, 48.63+166.05j, -51+102j, -78.63+46.05j, -85, -78.63-46.05j, -51-102j, 48.63-166.05j\}$ (Each stage 3 marks) ii) (b) $-W_N^k$	**1**	**1**	**2**	**1**
3	**i)** X(k) = X∗(N – k) X(5) = X∗(8 − 5) = X∗(3) = 2 + j2 X(6) = X∗(8 − 2) = X∗(2) = j4 X(7) = X∗(8 − 7) = X∗(1) = 2 − j2 (2 marks) Each stage 2 marks (3*2=6 marks)  $8x^*(n) = \{8, 8, -8, -8, -8, 8, 8, -8\}$ $x(n) = \{1, 1, -1, -1, -1, 1, 1, -1\}$ Final answer 1 mark	**9**	**4**	**2**	**2**

	ii) c) 64 and 32	**1**	**2**	**2**	**1**
4	**i)**  (1 mark) $h_d(n)=\frac{1}{\pi n}\left[\sin(\pi.n)+\sin\left(\pi.n/3\right)-\sin\left(2\pi.n/3\right)\right] \quad -\infty \le n \le \infty$ (2 marks) **Truncating the desired impulse response $h_d(n)$ to 11 samples, we have** $h(n)=\begin{cases}\frac{1}{\pi n}\left[\sin(\pi.n)+\sin\left(\pi.n/3\right)-\sin\left(2\pi.n/3\right)\right] & -5\le n\le 5 \\ 0 & otherwise\end{cases}$ h(0)=0.667 h(1)=h(-1)=0 h(2)=h(-2)=0.2757 h(3)=h(-3)=0 h(4)=h(-4)=0 h(5)=h(-5)=0 (2 marks) $H(z)=0.667+0.2757\left[z^{-2}+z^{2}\right]-0.1378\left[z^{-4}+z^{4}\right]$ (3 marks) $H^{1}(z)=-0.1378z^{-1}+0.2757z^{-3}+0.667z^{-5}+0.2757z^{-7}-0.1378z^{-9}$ (1 mark) **ii)** a) Low pass filter	**9** **1**	**3** **1**	**3** **3**	**3** **1**
5	**i)** $h_d(n)=\frac{1}{\pi n}\left[\sin \pi n-\sin\frac{\pi}{4}n\right]$ $h_d(0)=0.75$ $h_d(-1)=h_d(1)=-0.225$ $h_d(-2)=h_d(2)=-0.159$ $h_d(-3)=h_d(3)=-0.075$ $h_d(-4)=h_d(4)=0$ $h_d(-5)=h_d(5)=0.045$ (2 marks) Hamming window $w_H(n)=0.54+0.46\cos\frac{\pi n}{5}$ for $-5\le n\le 5$ 0 otherwise	**9**	**3**	**3**	**3**

	$w_H(0) = 1$ $w_H(-1) = w_H(1) = 0.912$ $w_H(-2) = w_H(2) = 0.682$ $w_H(-3) = w_H(3) = 0.398$ $w_H(-4) = w_H(4) = 0.1678$ $w_H(-5) = w_H(5) = 0.08$ (2 marks) Filter coefficient using windowing $h(n) = h_d(n)\, w_H(n)$ for $-5 \le n \le 5$ 0 otherwise $h(0) = 0.75$ $h(-1) = h(1) = -0.2052$ $h(-2) = h(2) = -0.1084$ $h(-3) = h(3) = -0.03$ $h(-4) = h(4) = 0$ $h(-5) = h(5) = 0.0036$ (2 marks) Transfer function : (2 marks) $H(z) = 0.75 - 0.2052(z^{-1}+z) - 0.1084(z^{-2}+z^{2}) - 0.03(z^{-3}+z^{3}) + 0.0036(z^{-5}+z^{5})$ Realizable transfer function (1 mark) $H'(z) = z^{-5}H(z) = 0.75z^{-5} - 0.2052z^{-6} - 0.2052z^{-4} - 0.1084z^{-7} - 0.1084z^{-3} - 0.03z^{-8} - 0.03z^{-2} + 0.0036z^{-10} + 0.0036$ **ii)** b) Bandedge	**1**	**1**	**3**	**1**
6	**i)** $h_d(n) = \frac{1-\cos \pi n}{\pi n}$ (2 marks) $h_d(0) = 0$, $h_d(1) = -h_d(-1) = \frac{2}{\pi}$ $h_d(2) = -h_d(-2) = 0$, $h_d(3) = -h_d(3) = \frac{2}{3\pi}$ $h_d(4) = -h_d(-4) = 0$, $h_d(5) = -h_d(-5) = \frac{2}{5\pi}$ (2 marks)	**9**	**3**	**3**	**3**

	Rectangular window $w_R(n) = 1 \quad -5 \le n \le 5$ $0 \quad$ otherwise $h(n) = h_d(n) w_R(n) = h_d(n)$ for $-5 \le n \le 5$ (2 marks) Transfer function $H(z) = \frac{2}{\pi}(z - z^{-1}) + \frac{2}{3\pi}(z^3 - z^{-3}) + \frac{2}{5\pi}(z^5 - z^{-5})$ (2 marks) Realizable transfer function $H'(z) = z^{-5} H(z) = \frac{2}{5\pi} + \frac{2}{3\pi} z^{-2} + \frac{2}{\pi} z^{-4} - \frac{2}{\pi} z^{-6} - \frac{2}{3\pi} z^{-8} - \frac{2}{5\pi} z^{-10}$ (1 mark) **ii)** a) h(n)= -h(N-1-n)	**1**	**1**	**3**	**1**
7	**i)** $h_d(n) = \frac{1}{\pi}\left[\sin \pi n - \sin \frac{\pi}{4} n\right]$ (2 marks) h(0) = 0.75 h(1)=h(-1)= -0.225 h(2)=h(-2)= -0.159 h(3)=h(-3)= -0.075 h(4)=h(-4)=0 h(5)=h(-5)=0.045 (2 marks) **ii)**	**4** **5**	**4** **3**	**3** **2**	**2** **3**

	$H(z) = \frac{z}{z-0.5} + \frac{0.2z}{(z-0.2)^2}$ $H(z) = \frac{1}{1-0.5z^{-1}} + \frac{0.2z^{-1}}{1-0.4z^{-1}+0.04z^{-2}}$ (1 mark) $H_1(z)$ $H_2(z)$ For $H_1(z)$ $w(n) = x(n) + 0.4\,w(n-1) - 0.04\,w(n-2)$ $y(n) = 0.2\,w(n-1)$ For $H_2(z)$ $w(n) = x(n) + 0.5\,w(n-1)$ $y(n) = w(n)$ (1 mark)  (3 marks) **iii)** c) -6ω	**1**	**2**	**3**	**1**

Question Paper Setter

Approved by Audit Professor/ Course Coordinator