University Institute of Engineering & Technology

(Recognised Under Section 2(f) and 12B of UGC)

Kurukshetra University, Kurukshetra

TIME – 3 Hrs 15 Min

THEORY EXAMINATION – JAN 2021	
B.TECH - ECE	**SEMESTER – V**

M.M. - 56

PAPER - EC-309 | **SUBJECT- Digital Signal Processing**

INSTRUCTIONS TO BE FOLLOWED

- **Allotted time for examination is 3 hours 15 minutes that includes time for downloading the question paper, writing answers, scanning of answer sheets and E-mailing the PDF files to the designated Email ID.**
- **For ECE-A Regular Students, the Email ID is:- btech5thecea@kuk.ac.in**
- **For ECE-B Regular Students, the Email ID is:- btech5theceb@kuk.ac.in**
- **The candidates will be required to attempt 75% of the question paper (maximum) by choosing to their any best questions accumulating 56 marks.**
- **The PDF files should be saved as Roll No. and Subject Code. Proper attention should be given while sending the email and in the subject line, the Roll Number and Subject Code should be mentioned.**
- **Maximum Page Limit should be 20 (Twenty) for attempting the question paper on A4 sheets which could be downloaded and printed from the sample sheets given in the Kurukshetra University Examination guidelines.**
- **Over-attemptation should be avoided.**
- **Handwriting should be neat and clean and diagrams should be clear and contrasted.**
- **The candidate should not write their Mobile No. otherwise Unfair Means Case will be made.**
- **While attempting the paper, the candidate will use blue/black pen only.**
- **Before attempting the paper, the candidate will ensure that he/she has downloaded the correct question paper. No complaint for attempting wrong question paper by the candidate will be entertained.**
- **Candidate must ensure that he/she has put his/her signature on each page of the answer sheet used by him/her. Answer sheet without the signature of the candidate will not be evaluated.**

PART-A

Q. No. – 1 Answer the following questions. **15x1=15**

(i)	Evaluate the Z-transform of $n^2u(n)$?
(ii)	What is the Z-transform of the signal defined as $x(n)=u(n)-u(n-N)$?
(iii)	If $x(n)=Ae^{j\omega n}$ is the input of an LTI system and h(n) is the response of the system, then what is the output y(n) of the system?
(iv)	If $x(e^{j\omega})$ denotes the discrete time Fourier transform of the signal then what will be the value of DTFT of $x(-n)$?
(v)	Find the N-point DFT of $x(n) = a^n$ for $0 < a < 1$?
(vi)	When a filter is said to have linear phase *(write two conditions)*?
(vii)	If $x(n)$ is a finite duration sequence of length L, then write the discrete Fourier transform of it?
(viii)	What is the N^{th} root of unity W_N ?
(ix)	In IIR Filter design by the Bilinear Transformation, what type of the domain mapping is required to be done?
(x)	Write the function that defines a Chebyshev Polynomial of order N, $T_N(x)$?
(xi)	What is the width of the main lobe of the frequency response of a rectangular window of length M-1?
(xii)	What is the lowest order of the Butterworth filter with a pass band gain K_P = -1 dB at Ω_P = 4 rad/sec and stop band attenuation greater than or equal to 20dB at Ω_S = 8 rad/sec?
(xiii)	What is the magnitude of the frequency response of the system described by the difference equation $y(n)=ay(n-1)+bx(n)$, $0 < a < 1$?
(xiv)	How the even part of a signal x(t) can be evaluated?
(xv)	What is the value of average power of an energy signal?

PART-B

2	Find $x(n)$ using Convolution for the following function: $$X(z) = \frac{1}{(1-\frac{1}{2}z^{-1})(1+\frac{1}{4}z^{-1})}$$	**5**
3	Realise the given system function using Ladder structure: $$H(z) = \frac{2+8Z^{-1}+6Z^{-2}}{1+8Z^{-1}+12Z^{-2}}$$	**5**
4	Explain Alternation theorem and derive necessary expressions?	**5**
5	Determine H(z) using the impulse invariant technique for the following analog system function:	**5**

	$$H(s) = \frac{\mathbf{1}}{(s+0.5)(s^2+0.5s+2)}$$	

PART-C

6	Determine the inverse Z-transform using method of residue: $$X(Z) = \frac{\mathbf{1}}{(Z-0.25)(Z-0.5)}; ROC: \lvert Z\rvert > 0.5$$	**10**
7	Explain and derive the Goertzel Algorithm?	**10**
8	Using inverse FFT algorithm find *x(n)* for the *X(k)* given as: ***X(k) = {36, -4+j9.656, -4+j4, -4+j1.656, -4, -4-j1.656, -4-j4, -4-j9.656}***	**10**
9	Evaluate the DFT of *x(n) = {1, 1, 2 , 2 , 3 , 3}* and calculate the corresponding magnitude and phase spectrum?	**10**
10	Derive the expressions for frequency response of causal FIR filter with linear phase shift?	**10**
11	Design a low pass digital filter to match the ideal characteristics specified below using Fourier series method: $$H_r(f) = \begin{Bmatrix} \mathbf{1} & ; \lvert f\rvert \le f_p \\ \mathbf{0}; & f_p < \lvert f\rvert \le F/2 \end{Bmatrix}$$	**10**
12	Determine the order and the poles of a type I Low pass Chebyshev filter that has a 1-dB ripple in the passband, a cutoff frequency $\Omega_p = 1000\pi$, a stop band frequency of 2000π and an attenuation of 40dB or more for $\Omega \geq \Omega_s$?	**10**
13	Convert the analog low pass filter into digital filter for the following system functions: (i) $H(s) = \frac{1}{(s+0.1)^2+9}$ using backward difference derivatives (ii) $H(s) = \frac{\Omega_C}{s+\Omega_C}$ using bilinear transformation with 3dB bandwidth of 0.25π?	 **5** **5**