Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Programme Name: B. Tech Mechatronics
Course Name: Digital Signal Processing
Course Code: ELEG 364
Nos. of page(s): 02
Semester: VII
Time: 03 hrs.
Max. Marks: 100

Instructions: Attempt all questions. All questions are compulsory.

SECTION A

S. No.		**Marks**	**CO**
Q1	Prove the statement " Circular Convolution is Linear Convolution with Aliasing."	**5**	**CO3**
Q2	State and prove the following properties of continuous time Fourier transform: (i) Time shifting (ii) Frequency differentiation.	**5**	**CO1**
Q3	State and Prove convolution property of Discrete Time Fourier Transform. Using it, determine the convolution $x(n) = x_1(n) * x_2(n)$ of the sequences, where $x_1(n) = x_2(n) = \delta(n + 1) + \delta(n) + \delta(n - 1)$	**5**	**CO1**
Q4	Compute the z-transform and specify the ROC for $x(n) = e^{-\alpha n} \sin(\omega n)u(n)$.	**5**	**CO2**

SECTION B

Q5	Explain the process of windowing using illustrations. Obtain frequency domain characteristics of rectangular window function.	**10**	**CO4**
Q6	Given a sequence x(n), form a new sequence consisting of only the even samples of x(n); that is, $y(n) = x(2n)$. Determine the z transform of y(n) as a function of the z transform of x(n), using the auxiliary sequence $(-1)^n x(n)$.	**10**	**CO2**
Q7	An 8-point sequence is given by x[n]={2,2,2,2,1,1,1,1}. Compute its 8-point DFT by radix-2 DIT FFT Algorithm.	**10**	**CO3**
Q8	Design a type I lowpass Chebyshev filter that has a 1-dB ripple in the pass band, a cutoff frequency $\Omega_p = 1000\pi$, a stopband frequency of 2000π, and an attenuation of 40 dB or more for $\Omega \geq \Omega_s$. Also determine the order and poles of the filter.	**10**	**CO4**

SECTION-C

9	Cinema is a three-dimensional spatio-temporal signal that is sampled in time. In modern cinema, the sampling frequency in order to avoid aliasing is $\Omega_s = 24$ Hz. However, the persistence of vision is equivalent to a time filter with a bandwidth of $\Omega_{LP} = 48$ Hz. In order to avoid flickering and at the same time avoiding doubling the number of samples, in cinema one repeats each picture twice. For a given point on the screen, this is equivalent to having a train of impulses	**20**	**CO4**

	$g_i(t)=\sum_{-\infty}^{+\infty} g(n)\delta(t-nT)+\sum_{-\infty}^{+\infty} g(n)\delta(t-nT-T/2)$ where T = 1/24 Hz. Show that with the above scheme the persistence of vision allows the human visual system to have the impression of continuous movement.		
Q10	Design three bandpass digital filters, one with a central frequency of 770 Hz, a second of 852 Hz, and a third of 941 Hz. For the first filter, the stopband edges are at frequencies 697 and 852 Hz. For the second filter, the stopband edges are 770 and 941 Hz. For the third filter, the edges are at 852 and 1209 Hz. In all three filters, the minimum stopband attenuation is 40 dB and use Ω_s = 8 kHz.	**20**	**CO4**

Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Programme Name: B. Tech Mechatronics **Semester: VII**
Course Name: Digital Signal Processing **Time: 03 hrs.**
Course Code: ELEG 364 **Max. Marks: 100**
Nos. of page(s): 02
Instructions: Attempt all questions. All questions are compulsory.

SECTION A

S. No.		**Marks**	**CO**
Q1	Determine the inverse z transform of the following function of the complex variable z, supposing that the system is stable: $z^2 = \frac{z^2}{(z-a)(z-1)}$	**5**	**CO2**
Q2	Given a lowpass FIR filter with transfer function H(z), describe what happens to the filter frequency response when z is replaced by -z.	**5**	**CO2**
Q3	Consider the signal x(n) = [3, 2, 1, − 1, − 1, − 1, 0, 1, 2]. Write x(n) as a sum of even and odd discrete functions.	**5**	**CO1**
Q4	Explain the following statement: There is a unique discrete sinusoid x(n) with radial frequency $\lvert\omega\rvert \leq \pi$.	**5**	**CO1**

SECTION B

S. No.		**Marks**	**CO**
Q5	We define the even and odd parts of a complex sequence x(n) as: $E\{x(n)\} = \{x(n) + x*(-n)\}/2$ and $O\{x(n)\} = \{x(n) - x*(-n)\}/2$, respectively. Show that: $F\{E\{x(n)\}\} = \mathrm{Re}\{X(e^{j\omega})\}$ and $F\{O\{x(n)\}\} = j\,\mathrm{Im}\{X(e^{j\omega})\}$ where $X(e^{j\omega}) = F\{x(n)\}$.	**10**	**CO3**
Q6	Find the inverse FFT of the following using DIF algorithm : $X(k)=\{\underset{\uparrow}{1},1,1,1,1,1,1,0\}$	**10**	
Q7	Show that $\sum_{-\infty}^{+\infty} W_{nk} = ¿ \begin{cases} N, for\, k=0, \pm N, \pm 2N, \ldots ¿ \\ 0, otherwise \end{cases}$ where $W_{nk} = e^{-j(2\pi/N)k}$	**10**	**CO3**
Q8	Transform the continuous-time highpass transfer function given by $H(s) = \frac{s^2}{s^2+s+1}$ into a discrete-time transfer function using the impulse-invariance transformation method with Ωs = 10 rad/s. Plot the resulting analog and digital magnitude responses.	**10**	**CO4**

<table>
<tr><th colspan="4">SECTION-C</th></tr>
<tr><td>Q9</td><td>One wishes to measure the frequency content of a fast pulse x(t) using a digital computer. In order to do so, a fast data acquisition system detects the beginning of the pulse and digitalizes it. Knowing that:
(a) the pulse duration is of approximately 1 ns,
(b) it has no significant frequency components beyond 5 GHz,
(c) one needs to discriminate frequency components spaced of 10 MHz, one asks:
i. Determine the smallest sampling rate at the A/D converter of the data acquisition system that makes the desired measurement possible.
ii. Describe the measurement procedure, providing the relevant parameter values for the minimum sampling frequency case.</td><td>20</td><td>CO4</td></tr>
<tr><td>Q10</td><td>Design a lowpass filter using the frequency-response masking method satisfying the following specifications:
$A_p = 2.0$ dB
$A_r = 40$ dB
$\omega_p = 0.33\pi$ rad/sample
$\omega_r = 0.35\pi$ rad/sample.
Compare the results obtained with and without an efficient ripple margin distribution, with respect to the total number of multiplications per output sample, with the maximum passband ripple and with the resulting minimum stopband attenuation.</td><td>20</td><td>CO4</td></tr>
</table>