Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VII EXAMINATION – WINTER 2015**

**Subject Code: 170706** **Date:04/12/2015**

**Subject Name: Computer Signal Processing**

**Time: 10:30am to 1:00pm** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

**Q.1** **(a)** Explain the two conditions for LTI system: Linear and Time-invariant. State which of these conditions are satisfied for the systems: **07**

(i) y[n]=x[n-1]/x[n], if x[n] is not zero, y[n]=0 if x[n]=0; and

(ii) v[n]=(n+1)x[n].

**(b)** Explain the Causal, the Memory-less and the Recursive, properties of LTI (Linear Time-Invariant) systems. State which of these properties are satisfied for the system, y[n]= x[n] + 0.5 x[n-1] + 0.2 y[n-1], if the system is in zero state for n<0. **07**

**Q.2** **(a)** What is the function of anti-aliasing filter? Specify and sketch the frequency response of an anti-aliasing filter for sampling a continuous time speech signal at a sampling-rate of 8KHz. **07**

**(b)** Explain the criterion for sampling of a continuous-time audio signal. Also explain with a sketch the aliasing effect when the criterion is not satisfied. **07**

**OR**

**(b)** Output y[n] of a LTI system with the impulse response h[n] for any input x[n] can be shown as, $y[n]=\sum_{k\in Z} x[k]h[n-k]$. Derive the frequency response of the system from the above given equation by substitution of input $x[n]=\exp(j\omega n)$. **07**

**Q.3** **(a)** If $x[n]= 1+e^{j\pi n/2}$ is the input to an LTI system with the frequency response $H(z)=1-z^{-1}$ then derive the output y[n]. **07**

**(b)** Give a general difference equation of an ARMA (Auto-Recursive Moving Average) LTI system. Explain conversion of Direct Form – I to Direct Form – II realizations of a second order ARMA system. **07**

**OR**

**Q.3** **(a)** Give a general z-transform of a SOS (Second Order Section). Explain conversion of Direct Form –II to Transposed Form realization of the SOS. State the main advantage of using Transposed Form over the Direct Form. **07**

**(b)** Give the equations for computing N-point DFT (Discrete Fourier Transform) and IDFT (Inverse Discrete Fourier Transform). State and explain the periodic and discrete-ness properties of the DFT with appropriate illustrations. **07**

**Q.4** **(a)** State the necessary conditions for Causality and BIBO stability of any LTI system with a complex conjugate pair of poles at z = p and $z = p^*$ in z-plane. Also give sketch illustrations to justify the statements. **07**

**(b)** If x[n]={1, 2, 3, 4} is the input to a LTI system $H(z)=(1+2z^{-1}+z^{-2})$ then derive the corresponding output y[n] of the system. **07**

**OR**

**Q.4** **(a)** State and prove the convolution theorem of z-transform. **07**

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| | **(b)** | How many options are there for ROC of $H(z)=1/(1+(5/4)z^{-1}+(25/16)z^{-2})$. State in each of the ROC option whether the system is causal and stable or not? | **07** |
| **Q.5** | **(a)** | Write a short note on Windowing method for design of FIR filters. | **07** |
| | **(b)** | Sketch the functional block diagram of architecture of a DSP (Digital Signal Processor). | **07** |

**OR**

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| **Q.5** | **(a)** | Find the poles of the analog Butterworth prototype filter required for design of a second order digital LPF (Low Pass Filter) with cut-off frequency of $0.2\pi$ radians using Impulse Invariance mapping at sampling rate of 2Hz. | **07** |
| | **(b)** | Sketch the signal flaw graph for DIT (Decimation-in-Time) FFT algorithm. | **07** |

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