Veermata Jijabai Technological Institute

ESE B. Tech Third Year (Semester V)

181090071 01/12/2020

This is the subjective part of your examination. Write the answers on a paper, then scan and upload it in the appropriate classroom. All questions are compulsory.

R4ET3003T - Digital Signal Processing

Section 1: 10 marks per question 10

1. Attempt the following.

Q1 During our classroom discussions, we have studied at length that any function can be represented as weighted sum of complex exponentials. We have also studied its utility if the function is considered as signal or system with examples. Kriti is a regular student and has good command over rudimentary knowledge of applied mathematics. She tries to apply these concepts to a sinusoid function of 200Hz (yes maybe CT or DT). *10*

Would you like to help her apply this concept for representation? Substantiate your answer with valid analytical expressions and theoretical limitation (perhaps!) if you agree. In case you don't, why? Explain your denial with logical reasoning and physical significance.

Now, consider the following sequence, comment on its periodicity and hence compute its spectral components. $x(n) = 0.5 + 0.5\cos\left(\frac{2\pi n}{7}\right)$

Hence insinuate the utility of the same in filtering.

Section 2: 10 marks per question 10

1. Attempt the following.

Q2 During our classroom discussions, we have studied different transforms and energy/power relationship in either domain with h(n) being unit sample response a causal LTI system H(ω). *10*

Chintan claims that the frequency response can be completely specified by only real part of frequency response of a system i.e. may be uniquely recovered from its real part.

Mahesh opposes Chintan's proposition and gives an example to make his point.

Chintan rebuts Mahesh by giving a counter example to back his claim.

Mahesh refutes his argument again by giving another example.

Would you like to participate in this discussion, identify the point of views of both Mahesh and Chintan and their examples? Would you pacify both of them by giving an ultimate example so that everyone arrives at the unique conclusion? To support your answer in either case, only examples can't be produced as evidence and points must be clearly justified with suitable analytical expressions in general.

Section 3: 10 marks per question 10

1. Attempt the following.

Q3a Compare and contrast general purpose microprocessor and TMSC 320 processor. (maximum 2 points) *02*

b Recall the design of analog Butterworth filter and conformal mapping to convert into a digital filter. *08*

Medha is curious about utility of mathematical functions being used for filtering purpose. She tries to add four zeros at origin in the original analog Butterworth design. Mansoor suggests to scale the modified function so as to use it as a causal LTI system. Identify the modified function in general form and explain its utility.

Medha further converts her modified function to digital filter using conformal mapping. She discovers a unique relationship between digital versions of original digital Butterworth and digital filter obtained from her modified function. Mansoor points out that there are a few roots which are same in both the versions and proposes an alternate method to obtain an equivalent proposal as by Medha.

Identify the arguments made by each of them at each step. Enunciate its possible utility, mathematical significance in case of existence otherwise about its viability. Would you like to explicate the entire process?

Section 4: 10 marks per question 10

1. Attempt the following.

Q4 a Consider input x(n) and output y(n). Determine whether or not, there is a LTI, if yes, comment on its uniqueness and write the frequency response expression. If no, justify the same. *05*

i) x(n) = exp(jnπ/2) and y(n) = 0.25 exp(jnπ/2)

ii) $x(n) = \frac{\sin\left(\frac{\pi n}{6}\right)}{\pi n}; -\infty < n < \infty$ and $y(n) = \frac{\sin\left(\frac{\pi n}{3}\right)}{\pi n}; -\infty < n < \infty$

b During our classroom discussions we have verified the proof of the Nyquist theorem in detail, and studied the effects of choosing different sampling rates and corresponding reconstruction. *05*

Raghu tries to relate this concept with operations like x(an) (when a>1 and/or a<1) of a signal in time domain x(n). He finds strange and unexpected results when he tries to do the same operation in the transform domains (Z-domain and Fourier domain). Would you like to investigate the unexpected results as found by Raghu? Or, identify the flawed approach (if any) followed by him. Explain each step analytically and support your answer graphically considering practical implications.

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