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| **ASSIGNMENT** | |
| **Course Code** | ECC201A |
| **Course Name** | Signals and Systems |
| **Programme** | B.Tech |
| **Department** | CSE |
| **Faculty** | FET |

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| **Name of the Student** | Prachi Poddar |
| **Reg. No** | 17ETCS002122 |
| **Semester/Year** | 4TH/2ND |
| **Course Leader/s** | Dr T. Christy Bobby |

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| **Declaration Sheet** | | | | | | | | |
| Student Name | Prachi Poddar | | | | | | | |
| Reg. No | 17ETCS002122 | | | | | | | |
| Programme | B.Tech | | | | | Semester/Year | 4TH/2ND | |
| Course Code | ECC201A | | | | | | | |
| Course Title | Signals and Systems | | | | | | | |
| Course Date |  | | to | |  | | | |
| Course Leader | Dr T. Christy Bobby | | | | | | | |
| **Declaration**  The assignment submitted herewith is a result of my own investigations and that I have conformed to the guidelines against plagiarism as laid out in the Student Handbook. All sections of the text and results, which have been obtained from other sources, are fully referenced. I understand that cheating and plagiarism constitute a breach of University regulations and will be dealt with accordingly. | | | | | | | | |
| Signature of the Student | |  | | | | | Date |  |
| Submission date stamp  (by Examination & Assessment Section) | |  | | | | | | |
| Signature of the Course Leader and date | | | | Signature of the Reviewer and date | | | | |
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| **Faculty of Engineering and Technology** | | |  |
| **Ramaiah University of Applied Sciences** | | |  |
| Department | Electronic and Communication Engineering | Programme | B. Tech. in CSE |
| Semester/Batch | 4rd/2017 | |  |
| Course Code | ECC201A | Course Title | Signals and Systems |
| Course Leader(s) | Ms. Prafulla Kumari K. S & Dr T. Christy Bobby | |  |

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|  | | | **Assignment – 02** | | | | | | |
| **Reg.No.** | | | Prachi Poddar | | **Name of Student** | 17ETCS002122 | | | |
|  |  | |  | | |  |  |  | |
| **Sections** |  | | **Marking Scheme** | | |  | **Mar** | **ks** | |
| **Max**  **Marks** | **First**  **Examiner Marks** | **Moderator** | |
| **Part A** |  | |  | | |  |  |  | |
| A **1** | | Essay on DCT for Audio Signal Processing | | | 5 |  |  | |
|  | | **Part-A Max Marks** | | | **5** |  |  | |
| **Part B** |  | |  | | |  |  |  | |
| B **1.1** | | Formulation and solution of the difference equation | | | 6 |  |  | |
| B **1.2** | | Plotting of traffic | | | 2 |  |  | |
| B **1.3** | | Comments on the variability of the traffic | | | 2 |  |  | |
|  | | **B.1 Max Marks** | | | **10** |  |  | |
|  | |  | | |  |  |  | |
| B **2.1** | | Computation of Laplace Transforms 𝑊(𝑠), 𝐻(𝑠) and 𝑌(𝑠) | | | 2 |  |  | |
| B **2.2** | | Computation of the response when only secret signal is sent | | | 2 |  |  | |
| B **2.3** | | Recovery of the message signal | | | 3 |  |  | |
| B **2.4** | | Modification for the case with convolved inputs | | | 3 |  |  | |
|  | | **B.2 Max Marks** | | | **10** |  |  | |
|  |  | | **Total Assignment Marks** | | | **25** |  |  | |

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| **Course Marks Tabulation** | | | | |
| **Component-1 (B) Assignment** | **First**  **Examiner** | **Remarks** | **Moderator** | **Remarks** |
| A |  |  |  |  |
| B.1 |  |  |  |  |
| B.2 |  |  |  |  |
| **Marks (Max 25 )** |  |  |  |  |
| **Signature of First Examiner Signature of Moderator** | | | | |

**Please note:**

1. Documental evidence for all the components/parts of the assessment such as the reports, photographs, laboratory exam / tool tests are required to be attached to the assignment report in a proper order.
2. The First Examiner is required to mark the comments in RED ink and the Second Examiner’s comments should be in GREEN ink.
3. The marks for all the questions of the assignment have to be written only in the **Component – CET B: Assignment** table.
4. If the variation between the marks awarded by the first examiner and the second examiner lies within +/- 3 marks, then the marks allotted by the first examiner is considered to be final. If the variation is more than +/- 3 marks then both the examiners should resolve the issue in consultation with the Chairman BoE.

**Assignment - 02**

**Term - 2 Instructions to students:**

1. The assignment consists of 3 questions: Part A – **1** Question, Part B – **2** Questions.
2. Maximum marks is 2**5**.
3. The assignment has to be neatly word processed as per the prescribed format.
4. The maximum number of pages should be restricted to **12**.
5. Restrict your report for Part-A to 2 pages only.
6. Restrict your report for Part-B to a maximum of 10 pages.
7. The printed assignment must be submitted to the course leader.
8. **Submission Date:**
9. **Submission after the due date is not permitted.**
10. **IMPORTANT**: It is essential that all the sources used in preparation of the assignment must be suitably referenced in the text.
11. Marks will be awarded only to the sections and subsections clearly indicated as per the problem statement/exercise/question

**Preamble**

This course deals with continuous‐time and discrete‐time signals and systems. Students are taught the various continuous‐time and discrete‐time signals and systems, the underlying mathematics required for analysis and understanding of signals and systems including Fourier theory, Laplace and Ztransforms. Students are also taught to perform time and frequency domain analysis of systems including stability and are exposed to software tools for solving signals and systems problems.

**Part-A (05 Marks)**

Discrete Fourier Transform (DFT) is an essential theoretical and practical technique in signals and systems. Discrete Cosine Transform (DCT) is a special form of DFT employed for analysis and compression of audio and video signals.

In this context, write an essay on the topic: “**Discrete Cosine Transform for Audio Signal Processing”**

A discrete cosine transform (DCT) communicates a finite sequence of data focuses regarding a sum of cosine functions oscillating at different frequencies. DCTs are important to various applications in science and engineering, from lossy compression of audio (for example MP3) and images (for example JPEG), to spectral methods for the numerical arrangement of partial differential equations. The utilization of cosine rather than sine functions is basic for compression, since for reasons unknown, less cosine functions are expected to approximate a typical signal, though for differential equations the cosines express a specific decision of limit conditions.

Specifically, a DCT is a Fourier-related transform like the discrete Fourier transform (DFT), yet utilizing just real numbers. The DCTs are commonly related to Fourier Series coefficients of a periodically and symmetrically expanded sequence while DFTs are related to Fourier Series coefficients of a periodically broadened sequence. DCTs are proportional to DFTs of generally double the length, operating on real data with even symmetry, though in certain variations the info and/or yield data are moved significantly a sample. There are eight standard DCT variations, of which four are normal.

In the course of recent years, there has been an expanded enthusiasm for the investigation of compacted inspecting (CS),a new framework for examining and packing certain signals. In CS, the band restricted model is supplanted by an inadequate model, assuming that a signal can be productively spoken to utilizing just a couple huge coefficients in some transform domain. The notable work by and demonstrated that such a signal can be accurately reproduced from just a little arrangement of random straight estimations, suggesting the capability of dramatic decrease of inspecting rates, control consumption and computation intricacy in advanced data acquisitions.

Because of the extensive measure of data in picture signals, CS is very attractive in imaging applications, particularly for low-control and low goals imaging gadgets or when the estimation is all around expensive. Since the revelation of the CS theory, a few compressive imaging algorithms have been created for Fourier transform domain estimations in applications, for example, the X-ray. In spite of the previously mentioned work, there still exists a gigantic hole between the CS theory and applications to audio signals. Specifically, it is as yet obscure how to build a scanty audio signal, particularly when CS depends on two standards: sparsity, and ambiguity. For the issue of making a scanty representation of an audio signal, we present the DCT which is at present, the most broadly utilized transform for picture and video compression systems. Its fame is expected for the most part to the reality that it accomplishes a decent data compaction, since it concentrates the information content in relatively few coefficients. This implies that we can acquire a compacted variant of an audio signal by first getting an inadequate representation in the recurrence domain, and later preparing the outcome with a CS algorithm.

**Part B (20 Marks)**

**B.1 (10 Marks)**

A Difference Equation model for the traffic (average number of queries per hour) is being developed to tune the performance of a database server. It is identified that the traffic during the current hour depends on the traffic during past two hours and on external factors. The external factors are found to be of the form 𝐴 cos(Ω𝑛). Using the given traffic data and model parameter values, the student has to perform the following:

# **Question No. B1**

**Solution to Question No. B1:**

## B1.1 Formulate and solve the difference equation using the given data:

Given,

y(n) = a­1­ y(n-1) + a­2­ y(n-2) + x(n)

x(n) = Acos(nπ) = A(-1)**n**

y(0) = d0 and y(1) = d1

A = 3 , a1= 5 and a2 =-4

d0 = 4 and d1 = 7

Therefore equations will be as follows

**y(n) = 5y(n-1) – 4y(n-2) + x(n)**

**x(n) = 3(-1)n**

**y(0) = 4** and **y(1) = 7**

🡺y(n) – 5y(n-1) + 4y(n-2) = x(n)

Therefore auxillary equations will be

**1 – 5r-1 + 4r-2 = 0**

r**2**– 5r + 4 = 0

r2 – r – 4r + 4 = 0

r(r-4) – 1(r-4) = 0 🡺 (r-1)(r-4)=0

Therefore, r = 1 , 4

Natural Response will be given as

**yn(n) = c1(1)n + c2(4)n**

We know that, x(n) = 3(-1)n

Particular solution will be given as

y**p**(n) = k(-1)n

y(n-1) = k(-1)n-1 = **-** k(-1)n

y(n-2) = k(-1)n-2 = k(-1)n

k(-1)n + 5k(-1)n  + 4k(-1)n = 3(-1)n

k + 5k +4k = 3

k = 3/10

**y p(n) = (3/10)(-1)n**

Therefore, total response will be

**y(n) = y n(n) + y p(n)**

y(n) = c1(1)n + c2(4)n + (3/10)(-1)n

From, y(n) – 5y(n-1) + 4y(n-2) = x(n)

y(2) = 5y(2-1) – 4y(2-2) + x(2) = 5y(1) – 4y(0) + 3(-1)2 = 5\*7 – 4\* 4 +3 = 35-16+3 =22

**y(2) = 22**

y(3) = 5y(3-1) – 4y(3-2) + x(3) = 5y(2) – 4y(1) + 2(-1)3 = 5\* 22 – 4\* 7 -3 = 110-28-3 = 79

**y(3) = 79**

🡺y(n) = c1(1)n + c2(4)n + (3/10)(-1)n

using, y(2) =7 in above equation we get,

22 = c1(1)2 + c2(4)2+ (3/10)(-1)2

22 = c1 + 16c2 + (3/10)

c1 + 16c2 = 22 – (3/10)

c1 + 16c2 = 217/10 ……..(1)

Now using, y(3) = 2 in the same equation we get,

79 = c1(1)3 + c2(4)3 + (3/10)(-1)3

79 = c1 + 64c2 – 3/10

c1 + 64c2 = 79 + (3/10)

c1 + 64c2 = 793/10 ………(2)

Solving equation 1 and 2 simultaneously we get the values of c1 and c2 as,

**c1 = 2.5** and **c2 = 1.2**

Therefore substituting the values of c1 and c3 in total response equation it will be,

**y(n) = 2.5(1)n +(1.2)(4)n + (3/10)(-1)n**

Therefore the solution of the differential equation using the given data is

**y(n) = 2.5 (1)n + (1.2)(4)n + (3/10)(-1)n**

## B1.2 Plot the traffic as a function of n=0,1,….50:



**Fig 1 Graph for traffic as a function of n from 0 to 50**

**Matlab Code**

>> n = linspace(0,50,50);

>> y = (2.5\*(1.^n)) + (1.2\*(4.^n))+((3/10)\*((-1).^n));

>> stem(n,y)

## B1.3 Comment on the variability of the traffic using the solution:

From the graph it can be said that for n=0 to n=45(approx), graph is almost at 0 i.e y(n) from 0 to 45 is approximately 0 and from n=45, graph is increased in negative axis. For n=50 y(n) is -18\*1022. Therefore the graph is increaing downwards i.e on the negative side of y axis. Therefore for more number of values of n, y(n) is negative.

**B.2** **(10 Marks)**

A data security system uses digital watermarking by adding the message signal 𝑚(𝑡) with a secret (watermark) signal 𝑤(𝑡) to form the signal 𝑠(𝑡) = 𝑚(𝑡) + 𝑤(𝑡) transmitted to the receiver. The received signal is denoted by 𝑦(𝑡). The secret signal is known only to the sender and receiver. The transmission channel is assumed to be a Linear Time Invariant (LTI) system with an Impulse Response ℎ(𝑡). Based on the 𝑤(𝑡), 𝑦(𝑡) and ℎ(𝑡) given, the student has to perform the following:

**Note:** Consult the course leader for the relevant data.

Given, **a = 9; b = 4; c= 6;**

m(t) = e­­**-at**­ u(-t) ⇒ **m(t) = e-9t u(-t)**

w(t) = e­­**-bt**­ u(-t) ⇒ **w(t) = e-4t u(t)**

h(t) = c­ u(t) ⇒ **h(t) = 6 u(t)**

## 

## B2.1 Compute the laplace transform W(s), H(s) and Y(s):

Y(s) = H(s)[M(s) + W(s)]= H(s) M(s) + H(s) W(s)

## B2.2 Compute the response V(s) of the system when only w(t) is transmitted over h(t):

When only w(t) is transmitted over h(t) then,

v(t) = w(t) \* h(t)

Using property,

V(s) = W(s).H(s)

Therefore, the response V(s) will be,

## B2.3 Recover the message signal m(t) from Y(s):

Y(s) – V(s) = H(s) M(s)

Therefore, L­­-1­­[M(s)] = m(t)

m(t) = L­­-1­­ = - e-9t = e-9t u(-t)

Message signal m(t) recovered from Y(s) is

## B2.4 Analyse the effect of change in operation between the message and the watermark on the response(w(t) and m(t) are convolved instead of beign added):

y(t) = w(t) \* m(t) \* h(t)

Y(s) = W(s) \* M(s) \* H(s)

Therefore, the effect of change in operation between the message and the watermark is,

\*\*\*\*\*\*\*\*