Study Guide: DSPR 401

Digital Signal Processing 4

2016
SUBJECT: DIGITAL SIGNAL PROCESSING 4
CODE: DSPR401
PRE-REQUISITES: Engineering Mathematics 4
CONTACT TIME: Three lecture periods per week.
PURPOSE: The purpose of the course is to equip the student with analytical and computational skills that he will need when working with the hardware and software of DSP systems.

ASSESSMENT: Laboratory Tasks [10% of Final Mark and 80% pass compulsory]
Written Assessments [50% sub-minimum on each]

PASS REQUIREMENTS

- Each student must obtain a sub-minimum of 50% in each assessment.
- To pass each student must obtain an overall average theory mark of 50% or more and 80% in each of the compulsory designated laboratory exercises.
- Students who have not met all the above requirements will be required to re-enroll and repeat ALL assessments.

REWrites during the course

- ONE REWRITE will be granted to students who have failed to obtain 50% in no more than two assessments.
- This rewrite will take place at the end of the semester before the final marks are published and will include all work covered from the beginning of the course/semester.
- A rewritten assessment that is passed with 50% or more will have the score recorded as 50%.

PRACTICAL SESSIONS

The specified criteria (80% pass) for required laboratory exercises must be met by all students in order to pass the subject, 10% weighting is attached to these for calculating the final mark. Opportunities will be provided outside the normal laboratory schedule for students who need extra time to meet the criteria but this will terminate at the end of the week following the last week of lectures.
DISTINCTION REQUIREMENTS

To pass this course with distinction the student must
  = meet the above criteria for the assessments and laboratory exercises
  = obtain the sub-minimum of 50% on all written tests without rewrites
  = score an overall average of 75% on the written assessments

MODERATION

The assessments will be moderated according to DUT policy by an external moderator.

PRESCRIBED TEXT BOOK (COMPULSORY)

This text will be purchased in bulk by the Department using levy funds and distributed to registered students on production of suitable ID at the first lecture. Please note that the student’s name must appear on the central administrative computer system.


SUGGESTED BACKGROUND MATERIAL (OPTIONAL)


LECTURER

Mr. K.E. Moorgas kevinm@dut.ac.za
S8 - 110 Steve Biko Campus Personal extension: 031 373 2977
Departmental Secretary: 031 204 2932

VENUE

The venue to be announced based on the number of students on the Steve Biko Campus.

COMMUNICATIONS

Please email: kevinm@dut.ac.za
# SUBJECT OUTCOMES, ASSESSMENT CRITERIA AND SYLLABUS TOPICS

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Assessment method</th>
<th>Topics (with references to the prescribed text where applicable)</th>
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</thead>
<tbody>
<tr>
<td>1. Understand the difference between analog signal processing and digital signal processing</td>
<td>Written test/assignments</td>
<td>Chapter 1: Introduction</td>
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<tr>
<td>2. Know the advantages and disadvantage of DSP systems.</td>
<td>Requiring comprehension of content.</td>
<td>Overview of DSP Systems</td>
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<td>3. Know the basic components of a DSP system.</td>
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<td>Advantages of DSP</td>
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<td>Digital Filters</td>
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<td>Filter Concepts</td>
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<td>Signal Processing</td>
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<td>1. Know how to transform discrete signals using time shift and time reversal.</td>
<td>Written test/assignments practical exercises</td>
<td>Chapter 2: Discrete Signals</td>
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<td>2. Understand even and odd symmetry of signals.</td>
<td>Requiring recall and comprehension of content, analysis and calculation.</td>
<td>Signal Energy and Power</td>
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<td>3. Understand how to classify a discrete signal based on energy and power.</td>
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<td>Symmetry</td>
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<td>4. Understand the basics of interpolation and decimation</td>
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<td>Decimation and Interpolation</td>
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<td>5. Know how to find a digital frequency of a sinusoid or complex harmonic.</td>
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<td>Standard Discrete Signals</td>
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<td>6. Understand Sampling theorem, determine sampling rate.</td>
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<td>Discrete Time Harmonics</td>
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<td>7. Understand the concept of aliasing.</td>
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<td>Sampling Theorem</td>
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<td></td>
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<td>Aliasing</td>
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<td>1. Understand linearity, superposition, time invariance, and causality.</td>
<td>Written test/assignments practical exercises</td>
<td>Chapter 3: Time – Domain Analysis</td>
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<td>2. Understand linear time invariant (LTI) systems.</td>
<td>Requiring comprehension of content, analysis and calculation.</td>
<td>Discrete – Time Systems</td>
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<td>3. Know how to solve difference equations.</td>
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<td>Linearity and Superposition</td>
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<td>4. Know how to find impulse response of a system.</td>
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<td>Time Invariance</td>
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<td>5. Understand Causality</td>
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<td>LTI systems</td>
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<tr>
<td>6. Know how to find the impulse response of a system.</td>
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<td>Causality</td>
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<td>7. Know how to use the defining relation for convolution.</td>
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<td>Digital Filters</td>
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<td>Response of Digital Filters</td>
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<td>Difference Equations</td>
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<td>Impulse Response</td>
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<td>Discrete Convolution</td>
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<td>1. Understand the definition of z-Transforms.</td>
<td>Written test/assignments practical exercises</td>
<td>Chapter 4: z-Transform Analysis</td>
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<td>2. Understand the region of convergence ROC.</td>
<td>Requiring recall and comprehension of content, analysis and calculation</td>
<td>Two sided z-Transform</td>
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<td>3. Understand the concept of transfer functions, poles, and zeros.</td>
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<td>Region of Convergence (ROC)</td>
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<td>4. Know how to sketch a system realisation from the transfer function.</td>
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<td>Poles, Zeros, and the z-Plane</td>
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<td>5. Understand the properties of the z-Transform.</td>
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<td>Transfer Functions</td>
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<td>The Inverse z-Transform</td>
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<td>One Sided z-Transform</td>
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</table>
| 1. Understand the definition of the DTFT.  
2. Understand the concept of magnitude spectrum, gain, and phase.  
3. Know how to use the basic properties of the DTFT and find frequency responses.  
4. Know how to apply and analyse DTFT systems. | **Written test/assignments practical exercises**  
Requiring comprehension of content, analysis and calculation. | **Chapter 5: Frequency Domain Analysis**  
DTFT from the z-Transform  
Inverse DTFT  
Frequency Responses  
System Analysis using DTFT |
|---|---|---|
| 1. Understand the measures used to describe filter performance such as gain, phase delay, and group delay.  
2. Understand the concept of signal averaging and know how to find and sketch the frequency response of IIR and FIR averaging filters.  
3. Understand frequency responses and filter characteristics of Digital Filters. | **Written test/assignments practical exercises**  
Requiring recall and comprehension of content, analysis and calculation | **Chapter 6: Filter Concepts**  
Frequency Response and Filter Characteristics.  
FIR Filters and Linear Phase  
IIR Filters  
Gain |
| 1. Understand the concept of sampling.  
2. Know how to obtain the reconstructed signal from samples using various interpolating functions.  
3. Understand the concept of quantization. | **Written test/assignments practical exercises**  
Requiring recall and comprehension of content, analysis and calculation | **Chapter 7: Digital Processing of Analog Signals**  
Ideal Sampling  
Sampling, Interpolation, Signal Recovery  
Sampling Rate Conversion  
Quantization  
Digital Processing of Analog Signals |
| 1. Understand the DTF and the IDFT and know how to compute them.  
2. Understand how to relate the DFT and DTFT of discrete signals.  
3. Understand how to relate the Fourier Series (FT) coefficients of a periodic signal to the DFT of its sampled version.  
4. Understand how to relate the FT of an analog signal to the DFT of its sampled version.  
5. Know how to compute and apply the DFT. | **Written test/assignments practical exercises**  
Requiring recall and comprehension of content, analysis and calculation | **Chapter 8: The Discrete Fourier Transform**  
The DFT  
The DTFT and the DFT  
The DFT of Periodic Signals  
The FFT  
Inverse DFT |
| 1. Understand the concept of filter specifications.  
2. Know how to use the mappings to convert an analog filter to a digital filter.  
3. To be able to design a digital filter given specifications. | **Written test/assignments practical exercises**  
Requiring recall and comprehension of content, analysis and calculation. | **Chapter 9: Filter Design**  
IIR Filter Design  
FIR Filter Design |
Assessment criteria:

A) Theory Assessment (Overall sub-minimum at 50% or more)

3 tests = 90% of the overall mark.

B) Practical Assignment (Overall sub-minimum at 80%)

3 Practical Assignment = 10% of the overall mark.

Assessment criteria for each practical task will be detailed in a handout which will be distributed in the class during formal lecture or practical session. Each student will be assessed individually. Each student will be allowed 2 attempts for each practical task.

Final Mark Summary

Assessment 1 (30%) + Assessment 2 (30%) + Assessment 3 (30%) + Practical Assignment (10%) = Total Mark (100%)

Each Practical Task must be completed with 80% or the student’s final mark will be recorded as a fail.