

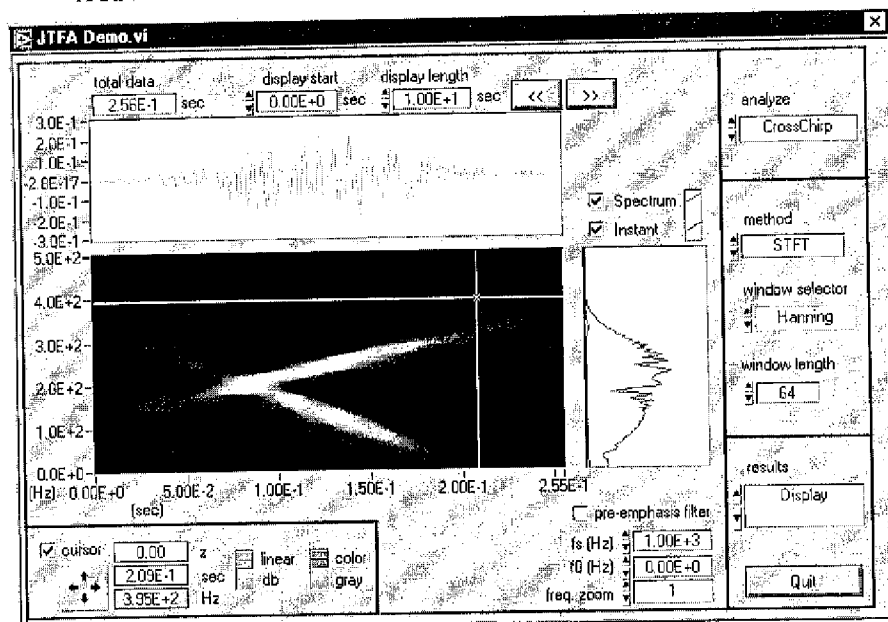
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STUDENT NUMBER: _____



The University of Western Australia
Master of Clinical Audiology

AUDIOLOGY IN THE FACULTY OF MEDICINE & DENTISTRY



AUDIOLOGICAL INSTRUMENTATION 511

SECOND SEMESTER EXAMINATION 2001

This paper is a three hour examination and contains three sections.

- Section A is a multiple choice question section of 20 questions (total time 30 minutes)
- Section B is a short answer section with 6 questions (total time 50 minutes)
- Section C is an essay section requiring 4 out of 5 essays (total time 100 minutes)

Marks are allocated pro rata (e.g. the essay section is worth 100/180th of the exam mark).

Answer sections A & B on this paper.

Answer Section C with one essay per answer book.

You have 10 minutes of reading time.

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PART A MULTIPLE CHOICE SECTION (about 30 minutes)

Clearly **CIRCLE** the most correct response.

There should be only one response for each question.

Marks will be corrected for incorrect responses (1/5th mark deducted for a wrong response)

1. In a bioamplifier, the earth electrode is included
 - a. to protect from electric shock
 - b. to stabilise the equipment against oscillations
 - c. to reduce pickup of radiated electrical interference
 - d. to provide a DC path for the trigger pulse
 - e. to optimise the filtering of the bioamplifier

2. The differential electrodes of a bioamplifier include
 - a. active and indifferent
 - b. active and earth
 - c. indifferent and reference
 - d. the earth and reference
 - e. active, indifferent and earth.

3. From a stability and noise point of view, the metals most suited to skin electrodes are
 - a. aluminium, lead, cobalt
 - b. lead, copper, aluminium
 - c. silver, gold, aluminium
 - d. copper, mercury, zinc
 - e. silver, gold, lead

4. Chloriding a metal skin electrode is performed
 - a. to clean the electrode surface before application
 - b. to prevent an allergic response from the subject
 - c. to complete the chemical reaction with skin salts
 - d. to activate the adhesive coating of the electrode
 - e. to avoid a chemical reaction with the skin surface

5. The gain of an amplifier is
 - a. the ratio of the common mode to the differential mode
 - b. the increase in efficiency of one test system over another
 - c. the number obtained by dividing output by input
 - d. the number obtained by subtracting indifferent input from active input
 - e. none of the above

6. Opto-isolation is the process of
 - a. protecting the high gain amplifier against electrostatic charge
 - b. done to reduce responses from the visual system
 - c. unnecessary with adequate earthing of the subject
 - d. necessary on the active input but not on the indifferent input
 - e. reduces electrical interference by separating subject from electrical equipment

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7. In electrophysiological recordings, pre-filtering is performed
- to minimise interference during recording
 - to exclude trigger artefacts in the stimulus
 - to maintain a constant gain as electrode contact alters
 - to exclude unwanted artefacts of similar frequency content as the response
 - to remove large and noisy particles from the electrode surface
8. Averaging a signal is
- more efficient than prefiltering
 - should be unnecessary with most evoked signals
 - is a function of the subject
 - a and b
 - b and c
9. The dominant interference or noise in electrophysiological measurement
- is always muscle noise
 - is always electrode noise
 - is always radiated interference
 - is always quantisation noise
 - varies with circumstance and measurement technique
10. To increase signal-to-noise ratio by 100, how many responses must be averaged?
- 10
 - 100
 - 10,000
 - varies with electrode position
 - none of the above
11. In evoked responses, a synchronous stimulus artefact may be removed by
- averaging a large number of responses
 - the addition of dither noise before averaging
 - by jittering the timing of the trigger relative to the response
 - slowing the stimulus repetition rate
 - alternating the polarity of the stimulus
12. With regards to evoked responses, which of the following is correct?
- The average of the spectrum is the same as the spectrum of the average
 - "High-pass" means that acceptance threshold is too low
 - Evoked signals can lie between 1 microvolt and 100 microvolt
 - Mains interference can be removed by shielding, but not earthing
 - The reference electrode is the same as the earth electrode

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13. The speed of sound in air is about

- a. 1034m/s
- b. 3400m/s
- c. 300km/hr
- d. 340m/s
- e. 3000m

14. In acoustic modeling, the modeling process usually

- a. must model sound from a single speaker
- b. must include the velocity of sound and not just the sound level
- c. must take into account reflection, absorption and transmission of sound
- d. all of the above
- e. b and c

15. In digital sound recordings at CD quality the sample rate is 44.1kHz which means

- a. signals up to 44.1kHz can be recorded, but above 44.1kHz signals are attenuated
- b. that the quantisation noise is dramatically reduced, making for quieter playback.
- c. it is necessary to low-pass filter a signal at 44.1kHz to avoid distortion
- d. all of the above
- e. none of the above

16. If an analog signal were converted to a digital signal using an 8bit ADC process

- a. the quantisation noise would be $1/256^{\text{th}}$ of the ADC unit's full input voltage range
- b. the quantisation noise would be $1/256^{\text{th}}$ of the signal amplitude
- c. the signal-to-noise ratio would depend on the amplitude of the input signal
- d. a and b
- e. none of the above

17. Warble tones and filtered noise are used in sound-field testing (free-field testing)

- a. because they are cheaper to generate than simple pure tones
- b. to avoid the distortion within the amplifier and speakers
- c. to avoid problems associated with standing waves within the room
- d. to avoid synchronous artifacts in the averaging process
- e. none of the above.

18. In determining the attenuation of a sound proof room

- a. measurements should be made with the fan on and off
- b. sounds must be made within the sound proof room, close to the microphone
- c. the noise floor is determined first, before the door is opened
- d. sound level readings are necessary in the room and outside it
- e. none of the above

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19. The reverberation within a room is

- a. partly determined by the size of the room only
- b. partly by the reflection properties of the walls, floors and ceiling.
- c. is partly determined by the sound produced in the room
- d. a and b
- d. a, b and c

20. A car muffler is

- a. an acoustic low-pass filter
- b. an absorbent slab of foam to reflect engine sounds
- c. a tuned organ pipe resonator which removes high and low frequencies
- d. an acoustic high-pass filter
- e. an acoustic compliance

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PART B SHORT ANSWER SECTION (about 10 minutes per short answer)

(a) Briefly explain the terms reflection, absorption and transmission with respect to the acoustics of a room, and how they relate to reverberation within the room.

(b) Briefly describe the issues you would need to consider in choosing the recording electrodes for evoked response measurement.

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(c) Briefly describe the difference between the average of the spectrum and the spectrum of the average in evoked response measurement of time-varying signals, and explain how each does or does not represent a signals that are synchronous or asynchronous with the averaging process.

(d) Briefly describe the Fletscher-Munsen curves and their relationship to the A and C weighting curves and loudness perception.

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(e) Briefly explain the meaning of "signal-to-noise ratio" (SNR), and how averaging can improve an evoked response recording, and how the number of responses required varies with the improvement in signal-to-noise ratio needed.

(f) Explain briefly what is meant by low-pass, high-pass and band-pass filtering, and give an example of how such filtering is used to improve evoked response recordings.

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PART C ESSAY SECTION

Write essays on FOUR of the five topics (about 30 minutes per essay).

1. Describe and explain the use of noise weighting scales in the assessment of ambient noise. How do noise weighting scales relate to the normal frequency spectrum of a signal, and to the $1/3^{\text{rd}}$ octave band and octave band analysis used to describe a sound field? How are the weighting scales used arithmetically to correct a sound measurement from a microphone?
2. Define the terms sampling and quantisation, and explain how they arise and they lead to quantisation noise and aliasing. Give examples of quantisation and aliasing in audiology, and how they would affect recordings of sound or evoked electrical signals. Give clear numerical examples of both phenomena, and explain how quantisation and aliasing relate to sampling rate, the Nyquist sampling criteria (not the Nyquist feedback criteria). What is an anti-aliasing filter?
3. Acoustic modelling is used to determine the theoretical acoustic performance of a room. Explain the process of acoustic modelling, what parameters are taken into account in the modelling. Describe the processes an acoustic consultant might use to measure and reduce reverberation in a room.
4. When recording electrical evoked responses of any kind, whether from muscles or nerves, there are many technical problems that arise, including electrical noise. Write an essay on the issue of avoiding noise in evoked response recordings, under the headings of electrode noise, movement artefact, spontaneous biological noise, electrode placement, electrical artefacts, and the role of shielding, filtering and averaging in reducing the unwanted noise. Comment also on the issue of synchronous and asynchronous artefacts.
5. Describe the important technical issues to consider in buying and installing a sound proof room. How would you expect an acoustics consultant to check the room and report on its performance?