THE PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF APPLIED PHYSICS

SECOND SEMESTER (2022): Supplementary Examination

AP222 & BE321 Digital Signal Processing and Biomedical Applications

TIME ALLOWED: 3 HOURS

INFORMATION FOR STUDENTS:

1. You have **TEN (10) MINUTES to** read this paper. Do not write during this allocated time

2. There are **Five (5) Questions** in this Exam Booklet. **Answer ALL Questions**

3. All answers must be written in the **Answer Booklet**

4. COMPLETE STUDENT DETAILS ARE TO BE FILLED ON THE ANSWER BOOKLET - DO THIS NOW

5. Only drawing instruments and calculators are allowed on your desk. Textbooks and notebooks are **NOT** allowed

6. If you are found **Cheating** in this Exam, penalties specified by the **University** shall be applied.

7. TURN OFF all your mobile phones and place them on the floor under your seat before you start the examination

QUESTION 1 (4 + 8 + 8 = 20 Marks)

(a) Differentiate between casual and non-casual system

[4 Marks]

(b) Check whether the following systems are time-varying or time in-variant

i. $y(n) = 2x^2(n-1)$

[4 Marks]

ii. $y(n) = x\left(\frac{n}{2}\right)$

[4 Marks]

(c) Check whether the following systems are linear or non-linear

i. $y(n) = x(n) + \frac{1}{2x(n-1)}$

[4 Marks]

ii. $y(n) = n^2x(n)$

[4 Marks]

QUESTION 2 (10 + 10 = 20 Marks)

An analog input signal to a system is $V_{in}(t) = 3cos60\pi t$. This system is an operational amplifier having gain of 2.

(a) If this amplifier is a non-inverting amplifier, determine

i. The output function $V_{out}(t)$ of this type of amplifier

[4 Marks]

ii. Draw the input and output waveform of this type of amplifier

[6 Marks]

(b) If this amplifier is an inverting amplifier, determine

i. The output function $V_{out}(t)$ of this type of amplifier

[4 Marks]

ii. Draw the input and output waveform of this type of amplifier

[6 marks]

QUESTION 3 (4 + 2 + 14 = 20 Marks)

(a) To process analog signals by digital means, it must be first converted into digital forms. Name and define the function of these processes.

[4 Marks]

(b) Explain Quantization in terms of rounding and truncation

[2 Marks]

(c) The encoder converts the quantization values into a parallel digital signal corresponding to a binary coded version of decimal number. If an 8-bit quantizer is used to convert the input DC voltage ranges from 0 to 12V, calculate the following

i. Maximum quantization level

[2 Marks]

ii. The decimal value and the digital output of the converter corresponding to the each of the analog input given in the table below

Analog Input (V)	Decimal Number	Digital Output
0.9		
4.8		
7.2		
8.8		
10.24		
11.55		

[12 Marks]

QUESTION 4 (8 + 12 = 20 Marks)

(a) Draw a graphical representation of the piece-wise linear function $f(t)$ given below

$$f(t) = \begin{cases} 1, & t \geq \frac{1}{2} \\ t + \frac{1}{2}, & -\frac{1}{2} < t < \frac{1}{2} \\ 0, & t \leq -\frac{1}{2} \end{cases}$$

[8 Marks]

(b) Consider a discrete time signal $x(n)$ defined as follows:

$$x(n) = \begin{cases} 1 + \frac{n}{4}, & -4 \leq n \leq -1 \\ 1, & 0 \leq n \leq 4 \\ 0, & elsewhere \end{cases}$$

i. Determine the sequence of $x(n)$

[3 Marks]

ii. Sketch the signal $x(n)$

[3 Marks]

iii. Sketch the signal obtained if we first advance $x(n)$ by two sample and then time reverse the resulting signal

[3 Marks]

iv. Sketch the signal obtained if we first time reverse $x(n)$ and then delay by one sample

[3 Marks]

QUESTION 5 (3 + 3 + 14 = 20 Marks)

(a) Differentiate between analog signal and digital signal

[3 Marks]

(b) Define the term 'aliasing' with respect to Nyquist Sampling Theorem

[3 Marks]

(c) An analog signal $x_a(t) = cos4000\pi t + 4cos300\pi t + 3sin2\pi(6000)t$ is passed through a sampler and is sampled 4000 times per seconds.

i. Determine the frequency component of these signals

[2 Marks]

ii. Determine the Nyquist sampling rate of $x_a(t)$

[2 Marks]

iii. Determine the folding frequency

[2 Marks]

iv. What are the frequencies, in radians, in the resulting discrete-time signal $x(n)$

[4 Marks]

v. If $x(n)$ is passed through an ideal D/A converter, what is the reconstructed signal $y_a(t)$

[4 Marks]