CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE	:	SAB24203
COURSE NAME	:	SIGNALS AND SYSTEMS
PROGRAMME LEVEL	:	BACHELOR
DATE	:	26 JANUARY 2026
TIME	:	02.00 PM – 04.30 PM
DURATION	:	2 HOURS AND 30 MINUTES

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of TWO (2) sections.
4. Answer ALL questions in Section A and THREE (3) questions in Section B.
5. Please write your answers on the answer booklet and graph paper provided.
6. Answer all questions in English language ONLY.
7. Refer to the attached Formula.

THERE ARE 6 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

Answer ALL questions in this section.
Please use the answer booklet provided.

Question 1

(a) Describe the meaning of discrete-time signal and sketch its waveform in the graph paper.

(5 marks)

(b) Explain the reasons for the use of mathematical equations in representing physical system.

(5 marks)

(c) For each signal shown in **Figure1(a)** and **Figure1(b),** construct the graph of its corresponding even and odd part.

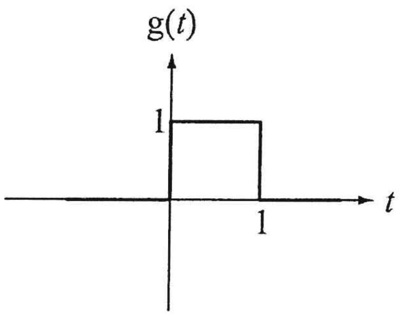


Figure 1(a)

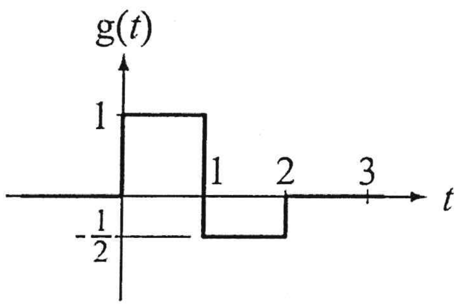


Figure 1 (b)

(10 marks)

Question 2

(a) One period of a periodic signal $x(t)$ with fundamental period of T_0 is shown in **Figure 3**. Calculate the amplitude of the signal $x(t)$ at time $t = 40ms$ and $t = 240ms$.

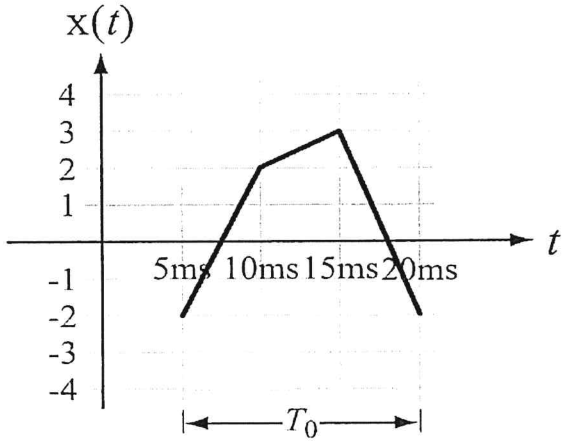


Figure 3: Signal with fundamental period of T_0

(4 marks)

(b) For the given signals in **Figure 4 (a) and (b)**, derive the signal equation in terms of unit step and ramp function. Then prove each derived equation by substituting $t = 0$ and $t = 2$ second.

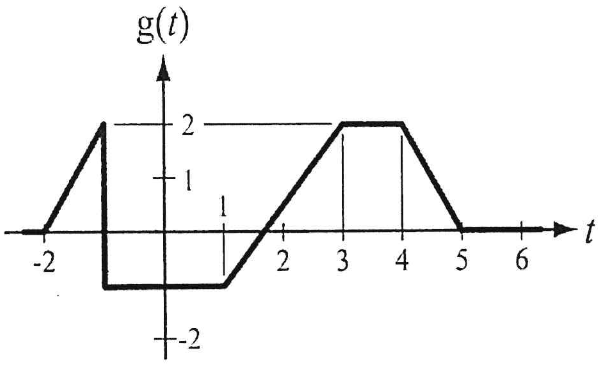
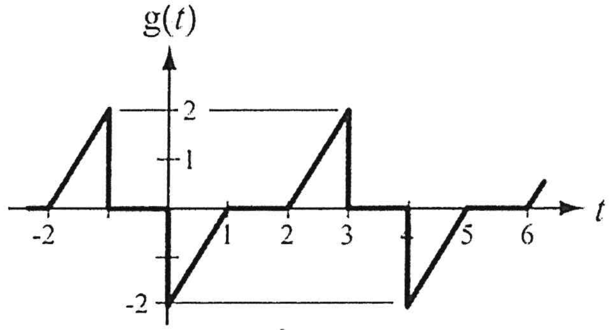


Figure 4(a): Signal with time range of -2 to 6 second

(8 marks)



g(t) is periodic with fundamental period, 4

Figure 4(b): Signal with time range of -2 to 2 second.

(8 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.
Please use the answer booklet provided.

Question 3

(a) Sketch the continuous signals and discrete signals in the graph paper Label the x and y axis clearly. Then elaborate the differences between the two signals by providing examples.

(8 marks)

(b) Illustrate the process of converting an analog signal to digital signal in block diagram. Explain the function of each block during the conversion process.

(12 marks)

Question 4

Convolution is an important process in signal processing. It includes other applications such as in probability, statistics, acoustics, spectroscopy and image processing, geophysics, engineering, physics, computer vision and differential equations.

(a) Explain the definition of signal convolution.

(5 marks)

(b) Given the discrete signals in **Figure 5**. Perform the convolution using mathematical method. Then, using the graph paper, sketch the convolution output $y(n)$.

Note: $h(n) = [0\ \ 0\ \ 0\ \ 0.1\ \ 0.3\ \ 0.7\ \ 1\ \ 0.7\ \ 0.3\ \ 0.1]$

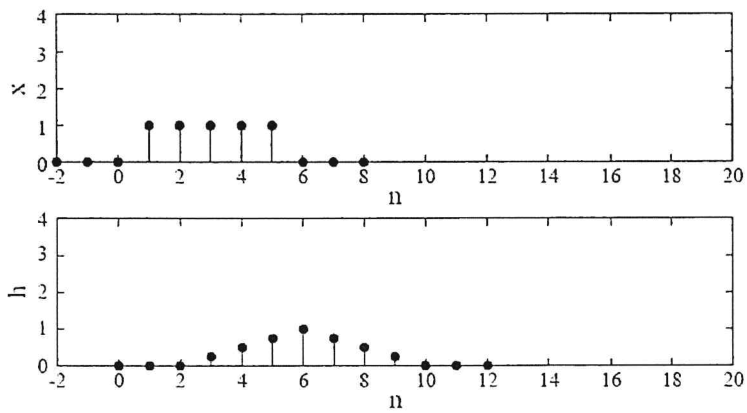


Figure 5: Discrete signals $x(n)$ and $h(n)$

(15 marks)

Question 5

For the discrete system block diagram shown in **Figure 6**, derive its difference equation. Then calculate the output, $y(n)$, if the input is $x(n) = [\,1 \;\; 1 \;\; 1 \;\; 1\,]$

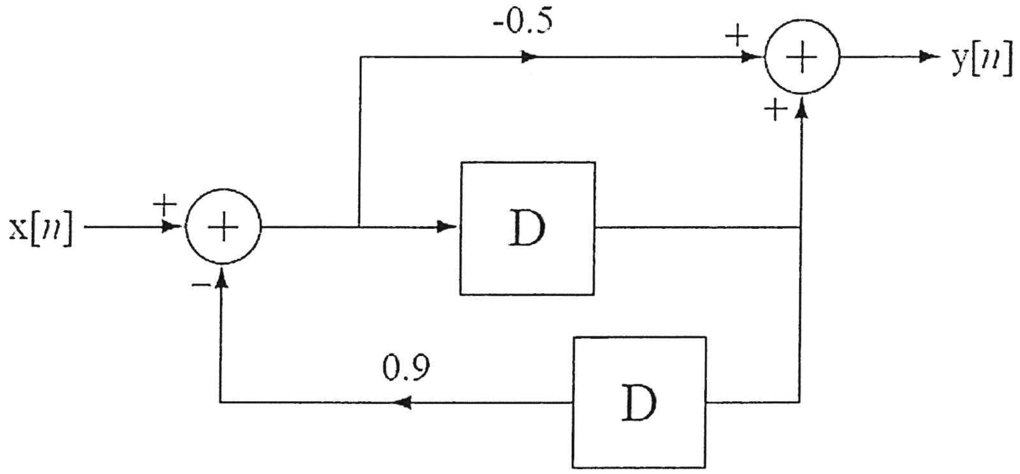


Figure 6: Discrete system block diagram

(20 marks)

Question 6

(a) Linear Time Invariant System (LTI) is the system used throughout this course for signal analysis due to its simplicity. It is a system that produces an output signal from any input signal subject to the constraints of linearity and time-invariance.

i. Write the input and output mathematical equation that represents a LTI system. Define all the parameters involved in the equation.

(4 marks)

ii. State the properties needed for LTI systems in series and in parallel connection.

(4 marks)

iii. State the condition for LTI system to be stable.

(2 marks)

(b) Apply the Laplace transform given in Appendix to convert the following signals to its equivalent s-domain function.

i. $x(t) = cos(3t)$

(2 marks)

ii. $x(t) = \sin(2t)\cos(2t)$

(4 marks)

iii. $x(t) = te^{2t}\sin(3t)$

(4 marks)

END OF EXAMINATION PAPER

APPENDIX

Z-TRANSFORM PAIRS

$$\delta[n] \xleftrightarrow{z} 1, \quad \text{All } z$$

$$\mathrm{u}[n] \xleftrightarrow{z} \frac{z}{z-1} = \frac{1}{1-z^{-1}}, \quad |z|>1, \qquad -\mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z}{z-1}, \quad |z|<1$$

$$\alpha^n \mathrm{u}[n] \xleftrightarrow{z} \frac{z}{z-\alpha} = \frac{1}{1-\alpha z^{-1}}, \quad |z|>|\alpha|, \qquad -\alpha^n \mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z}{z-\alpha} = \frac{1}{1-\alpha z^{-1}}, \quad |z|<|\alpha|$$

$$n\,\mathrm{u}[n] \xleftrightarrow{z} \frac{z}{(z-1)^2} = \frac{z^{-1}}{\left(1-z^{-1}\right)^2}, \quad |z|>1, \qquad -n\,\mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z}{(z-1)^2} = \frac{z^{-1}}{\left(1-z^{-1}\right)^2}, \quad |z|<1$$

$$n^2 \mathrm{u}[n] \xleftrightarrow{z} \frac{z(z+1)}{(z-1)^3} = \frac{1+z^{-1}}{z\left(1-z^{-1}\right)^3}, \quad |z|>1, \qquad -n^2 \mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z(z+1)}{(z-1)^3} = \frac{1+z^{-1}}{z\left(1-z^{-1}\right)^3}, \quad |z|<1$$

$$n\alpha^n \mathrm{u}[n] \xleftrightarrow{z} \frac{\alpha z}{(z-\alpha)^2} = \frac{\alpha z^{-1}}{\left(1-\alpha z^{-1}\right)^2}, \quad |z|>|\alpha|, \qquad -n\alpha^n \mathrm{u}[-n-1] \xleftrightarrow{z} \frac{\alpha z}{(z-\alpha)^2} = \frac{\alpha z^{-1}}{\left(1-\alpha z^{-1}\right)^2}, \quad |z|<|\alpha|$$

$$\sin(\Omega_0 n)\mathrm{u}[n] \xleftrightarrow{z} \frac{z\sin(\Omega_0)}{z^2-2z\cos(\Omega_0)+1}, \quad |z|>1, \qquad -\sin(\Omega_0 n)\mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z\sin(\Omega_0)}{z^2-2z\cos(\Omega_0)+1}, \quad |z|<1$$

$$\cos(\Omega_0 n)\mathrm{u}[n] \xleftrightarrow{z} \frac{z[z-\cos(\Omega_0)]}{z^2-2z\cos(\Omega_0)+1}, \quad |z|>1, \qquad -\cos(\Omega_0 n)\mathrm{u}[-n-1] \xleftrightarrow{z} = \frac{z[z-\cos(\Omega_0)]}{z^2-2z\cos(\Omega_0)+1}, \quad |z|<1$$

$$\alpha^n \sin(\Omega_0 n)\mathrm{u}[n] \xleftrightarrow{z} \frac{z\alpha\sin(\Omega_0)}{z^2-2\alpha z\cos(\Omega_0)+\alpha^2}, \quad |z|>|\alpha|, \qquad -\alpha^n \sin(\Omega_0 n)\mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z\alpha\sin(\Omega_0)}{z^2-2\alpha z\cos(\Omega_0)+\alpha^2}, \quad |z|<|\alpha|$$

$$\alpha^n \cos(\Omega_0 n)\mathrm{u}[n] \xleftrightarrow{z} \frac{z[z-\alpha\cos(\Omega_0)]}{z^2-2\alpha z\cos(\Omega_0)+\alpha^2}, \quad |z|>|\alpha|, \qquad -\alpha^n \cos(\Omega_0 n)\mathrm{u}[-n-1] \xleftrightarrow{z} \frac{z[z-\alpha\cos(\Omega_0)]}{z^2-2\alpha z\cos(\Omega_0)+\alpha^2}, \quad |z|<|\alpha|$$

$$\alpha^{|n|} \xleftrightarrow{z} \frac{z}{z-\alpha} - \frac{z}{z-\alpha^{-1}}, \quad |\alpha|<|z|<\left|\alpha^{-1}\right|$$

$$\mathrm{u}[n-n_0]-\mathrm{u}[n-n_1] \xleftrightarrow{z} \frac{z}{z-1}\left(z^{-n_0}-z^{-n_1}\right) = \frac{z^{n_1-n_0-1}+z^{n_1-n_0-2}+\cdots+z+1}{z^{n_1-1}}, \quad |z|>0$$

LAPLACE TRANSFORM PAIRS

$$\delta(t) \xleftrightarrow{\mathcal{L}} 1, \quad \text{All } \sigma$$

$$u(t) \xleftrightarrow{\mathcal{L}} 1/s, \quad \sigma > 0 \qquad -u(-t) \xleftrightarrow{\mathcal{L}} 1/s, \quad \sigma < 0$$

$$\text{ramp}(t) = t\,u(t) \xleftrightarrow{\mathcal{L}} 1/s^2, \quad \sigma > 0 \qquad \text{ramp}(-t) = -t\,u(-t) \xleftrightarrow{\mathcal{L}} 1/s^2, \quad \sigma < 0$$

$$e^{-\alpha t}\,u(t) \xleftrightarrow{\mathcal{L}} 1/(s+\alpha), \quad \sigma > -\alpha \qquad -e^{-\alpha t}\,u(-t) \xleftrightarrow{\mathcal{L}} 1/(s+\alpha), \quad \sigma < -\alpha$$

$$t^n\,u(t) \xleftrightarrow{\mathcal{L}} n!/s^{n+1}, \quad \sigma > 0 \qquad -t^n\,u(-t) \xleftrightarrow{\mathcal{L}} n!/s^{n+1}, \quad \sigma < 0$$

$$te^{-\alpha t}\,u(t) \xleftrightarrow{\mathcal{L}} 1/(s+\alpha)^2, \quad \sigma > -\alpha \qquad -te^{-\alpha t}\,u(-t) \xleftrightarrow{\mathcal{L}} 1/(s+\alpha)^2, \quad \sigma < -\alpha$$

$$t^n e^{-\alpha t}\,u(t) \xleftrightarrow{\mathcal{L}} \frac{n!}{(s+\alpha)^{n+1}}, \quad \sigma > -\alpha \qquad -t^n e^{-\alpha t}\,u(-t) \xleftrightarrow{\mathcal{L}} \frac{n!}{(s+\alpha)^{n+1}}, \quad \sigma < -\alpha$$

$$\sin(\omega_0 t)\,u(t) \xleftrightarrow{\mathcal{L}} \frac{\omega_0}{s^2+\omega_0^2}, \quad \sigma > 0 \qquad -\sin(\omega_0 t)\,u(-t) \xleftrightarrow{\mathcal{L}} \frac{\omega_0}{s^2+\omega_0^2}, \quad \sigma < 0$$

$$\cos(\omega_0 t)\,u(t) \xleftrightarrow{\mathcal{L}} \frac{s}{s^2+\omega_0^2}, \quad \sigma > 0 \qquad -\cos(\omega_0 t)\,u(-t) \xleftrightarrow{\mathcal{L}} \frac{s}{s^2+\omega_0^2}, \quad \sigma < 0$$

$$e^{-\alpha t}\sin(\omega_0 t)\,u(t) \xleftrightarrow{\mathcal{L}} \frac{\omega_0}{(s+\alpha)^2+\omega_0^2}, \quad \sigma > -\alpha \qquad -e^{-\alpha t}\sin(\omega_0 t)\,u(-t) \xleftrightarrow{\mathcal{L}} \frac{\omega_0}{(s+\alpha)^2+\omega_0^2}, \quad \sigma < -\alpha$$

$$e^{-\alpha t}\cos(\omega_0 t)\,u(t) \xleftrightarrow{\mathcal{L}} \frac{s+\alpha}{(s+\alpha)^2+\omega_0^2}, \quad \sigma > -\alpha \qquad -e^{-\alpha t}\cos(\omega_0 t)\,u(-t) \xleftrightarrow{\mathcal{L}} \frac{s+\alpha}{(s+\alpha)^2+\omega_0^2}, \quad \sigma < -\alpha$$

$$e^{-\alpha|t|} \xleftrightarrow{\mathcal{L}} \frac{1}{s+\alpha} - \frac{1}{s-\alpha} = -\frac{2\alpha}{s^2-\alpha^2}, \quad -\alpha < \sigma < \alpha$$