CG2023
Midterm Quiz (2021/22-Sem 2) – Information

(1)	Date:	3 March 2022 (Week 7 - Thursday)
(2)	Time:	4:20 PM
(3)	Duration:	1.5 hours
(4)	Venue:	MPSH5 sections A and B (Please refer to Seat Assignment and MPSH5 floor plan.).
(5)	Scope:	The SIGNALS part of the module. Due to variations in the course materials used by different groups, please check with your group lecturer on the topics covered in relation to your group course materials.
(6)	Type:	Closed-book. You may bring one self-prepared A4-size crib sheet with you to the test venue. Rules for crib sheet preparation and usage are given in **Appendix A**.
(7)	Calculator:	Programmable and/or graphic calculators are not allowed.
(8)	Formulas:	Formulas shown in **Appendix B** will be provided together with the quiz paper. *DO NOT bring these formulas to the test venue.*
(9)	Make-up Quiz:	Eligibility to write a make-up quiz will follow NUS's rules governing the eligibility for an IC grade in the final exam.

(10) Make sure you have Green Pass in your uNivUS app before you come for the quiz.

IMPORTANT: Failure to follow instructions given in Items (6) and/or (7) above will be treated as a breach of NUS's Examination Rules, which entails disciplinary action.

Appendix A: CRIB-SHEET RULES

- You are allowed to bring **ONE (1)** self-prepared **A4-size** crib sheet to the midterm-quiz/examination.
- You may write on both sides of the crib sheet, making a total of 2 pages.
- The crib sheet may be handwritten or typewritten.
- The writing area of the crib sheet should NOT be increased by any means.
- Non-prescription visual aids are NOT allowed.

Appendix B: FORMULAS

Table of Fourier Transforms and Properties

FOURIER TRANSFORMS OF BASIC FUNCTIONS		
	$x(t)$	$X(f)$
Constant	K	$K\delta(f)$
Unit Impulse	$\delta(t)$	**1**
Unit Step	$u(t)$	$\frac{1}{2}\left[\delta(f)+\frac{1}{j\pi f}\right]$
Sign (or Signum)	$\operatorname{sgn}(t)$	$\frac{1}{j\pi f}$
Rectangle	$\operatorname{rect}\left(\frac{t}{T}\right)$	$T\operatorname{sinc}(fT)$
Triangle	$\operatorname{tri}\left(\frac{t}{T}\right)$	$T\operatorname{sinc}^2(fT)$
Sine Cardinal	$\operatorname{sinc}\left(\frac{t}{T}\right)$	$T\operatorname{rect}(fT)$
Complex Exponential	$\exp(j2\pi f_o t)$	$\delta(f-f_o)$
Cosine	$\cos(2\pi f_o t)$	$\frac{1}{2}\left[\delta(f-f_o)+\delta(f+f_o)\right]$
Sine	$\sin(2\pi f_o t)$	$-\frac{j}{2}\left[\delta(f-f_o)-\delta(f+f_o)\right]$
Gaussian	$\exp\left(-\frac{t^2}{\alpha^2}\right)$	$\alpha\pi^{0.5}\exp\left(-\alpha^2\pi^2 f^2\right)$
Comb	$\sum_{m=-\infty}^{\infty}\delta(t-mT)$	$\frac{1}{T}\sum_{k=-\infty}^{\infty}\delta\left(f-\frac{k}{T}\right)$

FOURIER TRANSFORM PROPERTIES		
	Time-domain	**Frequency-domain**
Linearity	$\alpha x_1(t)+\beta x_2(t)$	$\alpha X_1(f)+\beta X_2(f)$
Time scaling	$x(\beta t)$	$\frac{1}{\lvert\beta\rvert}X\left(\frac{f}{\beta}\right)$
Duality	$X(t)$	$x(-f)$
Time shifting	$x(t-t_o)$	$X(f)\exp(-j2\pi f t_o)$
Frequency shifting (Modulation)	$x(t)\exp(j2\pi f_o t)$	$X(f-f_o)$
Differentiation in the time-domain	$\frac{d^n}{dt^n}x(t)$	$(j2\pi f)^n X(f)$
Multiplication in the time-domain	$x_1(t)x_2(t)$	$\int_{-\infty}^{\infty}X_1(\zeta)X_2(f-\zeta)d\zeta$ or $X_1(f)*X_2(f)$
Convolution in the time-domain	$\int_{-\infty}^{\infty}x_1(\zeta)x_2(t-\zeta)d\zeta$ or $x_1(t)*x_2(t)$	$X_1(f)X_2(f)$
Integration in the time-domain	$\int_{-\infty}^{t}x(\tau)d\tau$	$\frac{1}{j2\pi f}X(f)+\frac{1}{2}X(0)\delta(f)$
		$\frac{1}{j2\pi f}X(f)$ **if** $X(0)=0$

Table of Trigonometric Identities and Basic Functions

Trigonometric Identities

$\exp(\pm j\theta) = \cos(\theta) \pm j\sin(\theta)$	$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$
$\cos(\theta) = 0.5\left[\exp(j\theta) + \exp(-j\theta)\right]$	$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$
$\sin(\theta) = -0.5j\left[\exp(j\theta) - \exp(-j\theta)\right]$	$\tan(\alpha \pm \beta) = \dfrac{\tan(\alpha) \pm \tan(\beta)}{1 \mp \tan(\alpha)\tan(\beta)}$
$\sin^2(\theta) + \cos^2(\theta) = 1$	
$\sin(2\theta) = 2\sin(\theta)\cos(\theta)$	$\sin(\alpha)\sin(\beta) = 0.5\left[\cos(\alpha - \beta) - \cos(\alpha + \beta)\right]$
$\cos(2\theta) = \cos^2(\theta) - \sin^2(\theta)$	$\cos(\alpha)\cos(\beta) = 0.5\left[\cos(\alpha - \beta) + \cos(\alpha + \beta)\right]$
$\sin^2(\theta) = 0.5\left[1 - \cos(2\theta)\right]$	$\sin(\alpha)\cos(\beta) = 0.5\left[\sin(\alpha - \beta) + \sin(\alpha + \beta)\right]$
$\cos^2(\theta) = 0.5\left[1 + \cos(2\theta)\right]$	$C\cos(\theta) - S\sin(\theta) = \sqrt{C^2 + S^2}\cos\left[\theta + \tan^{-1}\left(\dfrac{S}{C}\right)\right]$

Complex Unit: $\left(j = \sqrt{-1} = e^{j\pi/2} = e^{j90°}\right)$ $\left(-j = \dfrac{1}{j} = e^{-j\pi/2} = e^{-j90°}\right)$ $\left(j^2 = -1\right)$

Euler's Formula: $e^{j\theta} = \cos(\theta) + j\sin(\theta)$

Definitions of Basic Functions

Rectangle:

$$\text{rect}\left(\frac{t}{T}\right) = \begin{cases} 1; & -T/2 \le t < T/2 \\ 0; & \text{elsewhere} \end{cases}$$

Triangle:

$$\text{tri}\left(\frac{t}{T}\right) = \begin{cases} 1 - |t|/T; & |t| \le T \\ 0; & |t| > T \end{cases}$$

Sine Cardinal:

$$\text{sinc}\left(\frac{t}{T}\right) = \begin{cases} \dfrac{\sin(\pi t/T)}{\pi t/T}; & t \ne 0 \\ 1; & t = 0 \end{cases}$$

Signum:

$$\text{sgn}(t) = \begin{cases} 1; & t \ge 0 \\ -1; & t < 0 \end{cases}$$

Unit Impulse:

$$\delta(t) = \begin{cases} \infty\,; & t = 0 \\ 0\,; & t \ne 0 \end{cases} \qquad \int_{0^-}^{0^+} \delta(t)\,dt = 1$$

Unit Step:

$$u(t) = \begin{cases} 1\,; & t \ge 0 \\ 0\,; & t < 0 \end{cases}$$