SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

**SESI DISEMBER 2016**

**DEE 6122: SIGNAL AND SYSTEM**

**TARIKH : 05 APRIL 2017**
**MASA : 2.30PM – 4.30PM (2 JAM)**

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Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Bahagian A: Struktur (4 soalan)
Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Formula

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

SULIT

**SECTION A : 60 MARKS**

***BAHAGIAN A : 60 MARKAH***

**INSTRUCTION:**

This section consists of **FOUR (4)** structure questions. Answer **ALL** questions.

***ARAHAN :***

*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.*

**QUESTION 1**

***SOALAN 1***

CLO1 C1

(a) Identify the difference between even and odd signals.

*Kenal pasti perbezaan di antara isyarat genap dan ganjil.*

[3 marks]

[*3 markah*]

CLO1 C2

(b) Describe the signal of Unit Step Function u(t) and Unit Impulse Function, δ (t).

*Gambarkan isyarat Unit Step Function , u(t) dan Unit Impulse Function, δ (t)*

[5 marks]

[*5 markah*]

CLO1 C3

(c) Sketch x(t) = u (1-t) and x (t)= [u(t)-u(t-1)] for the continuous time signal shown in **Figure A1( c )**

*Lakar x(t) = u (1-t) dan x (t)= [u(t)-u(t-1)] untuk isyarat masa berterusan x(t) pada **Rajah A1( c )***

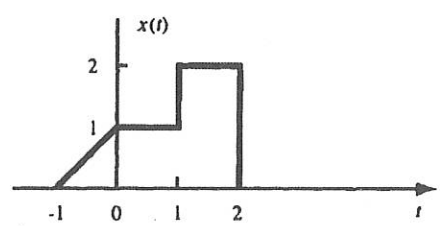



**Figure A1(c ) / *Rajah A1(c )***

[7 marks]

[*7 markah*]

**QUESTION 2**

***SOALAN 2***

CLO1 C1

(a) Define the convolution of two continuous time signals x(t) and h(t) denoted by

$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)\, h(t-\tau) d\tau$$

*Takrifkan konvolusi dua isyarat masa berterusan x(t) dan h(t) bagi persamaan*

$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)\, h(t-\tau) d\tau$$

[3 marks]

[*3 markah*]

CLO1 C2

(b) Express the input-output relationship for a block diagram of LTI system shown in **Figure A2(b).**

*Nyatakan hubungan data masukan dan keluaran bagi gambar rajah blok sistem LTI seperti dalam* ***Rajah A2(b).***

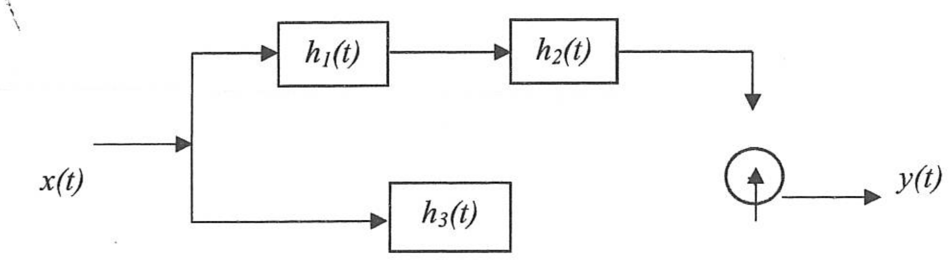



**Figure A2(b) /** ***Rajah A2(b)***

[5 marks]

[*5 markah*]





CLO1 C3

(c ) Sketch the output of y[n] = x [n] * h [n] with reference to the **Figure A2(c )** where

$x[n] = -\delta[n] + 2\delta[n-1] + \delta[n-2]$

$h[n] = \delta[n] + \delta[n-2]$

*Lakarkan keluaran bagi y[n] = x [n] * h [n] dengan merujuk kepada* ***Rajah A2(c )*** *di mana*

$x[n] = -\delta[n] + 2\delta[n-1] + \delta[n-2]$

$h[n] = \delta[n] + \delta[n-2]$

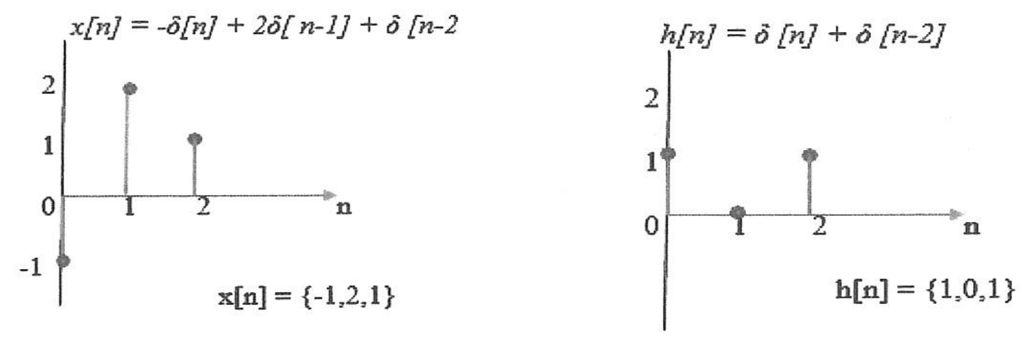



**Figure A2(c ) /** ***Rajah A2(c )***

[7 marks]

[*7 markah*]

## QUESTION 3

## *SOALAN 3*

CLO2 C1

(a) Identify the Region of Convergence (ROC) in Linear Time Invariant (LTI) System

*Kenalpasti "Region of Convergence" (ROC) dalam sistem "Linear Time Invariant" (LTI)*

[3 marks]

[3 *markah*]

CLO2 C2

(b) Compute the inverse of the following Laplace Transform using partial fraction method

$$X(s) = \frac{s+3}{s(s+1)}$$

*Kirakan Jelmaan Laplace Songsang bagi persamaan berikut menggunakan kaedah pecahan separa*

$$X(s) = \frac{s+3}{s(s+1)}$$

[5 marks]

[5 *markah*]

CLO2 C3

(c) Complete the Laplace Transform X(s) and sketch the pole zero with the ROC for the following signal x (t)

$$x(t) = e^{-t}u(t) + e^{2t}u(-t)$$

*Lengkapkan Jelmaan Laplace X(s) dan lakarkan kutub sifar dengan ROC bagi isyarat x(t) berikut :*

$$x(t) = e^{-t}u(t) + e^{2t}u(-t)$$

[7 marks]

[7 *markah*]





## QUESTION 4

## *SOALAN 4*

CLO2 C2

(a) Express the following signal to the complex exponential Fourier Series representation by using Eular's formula.

$$x(t) = \text{Cos } \omega_o t$$

*Ungkapkan isyarat berikut kepada kompleks eksponen Siri Fourier dengan menggunakan formula Eular's.*

$$x(t) = \text{Cos } \omega_o t$$

[3 marks]

[3 *markah*]

CLO2 C3

(b) Interpret the complex exponential Fourier Series for the following signal

$$X(t) = \text{Cos } 6t + \sin 4t \quad \text{where } \omega_o = 2$$

*Terangkan eksponen kompleks Siri Fourier bagi isyarat berikut*

$$X(t) = \text{Cos } 6t + \sin 4t \quad \text{where } \omega_o = 2$$

[5 marks]

[5 *markah*]

CLO2 C4

(c) Referring to **Figure A4(c),** determine the complex exponential Fourier Series of x(t)

*Merujuk kepada **Rajah A4(c),** Tentukan kompleks eksponen Siri Fourier bagi x(t)*

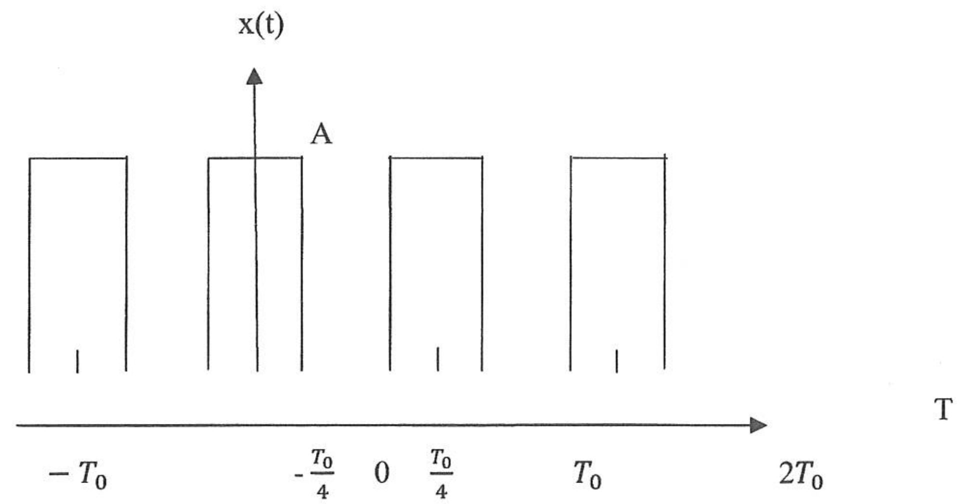



Figure A4(c) /*Rajah A 4(c)*

[7 marks]

[7 *markah*]

**SECTION B : 40 MARKS**

***BAHAGIAN B : 40 MARKAH***

**INSTRUCTION:**

This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

***ARAHAN:***

*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

**QUESTION 1**

***SOALAN 1***

CLO2 C3

Calculate the h(t) for causal LTI system and sketch the ROC for H(z) on the poles-zeros diagram for the following equation.

(Hint: Apply linearity and time delay properties to get the system function H(z) which is the equal to Y(z)/X(z) ).

$$y[n] - 3\,y[n-1] + 2y[n-2] = x[n].$$

*Kirakan h(t) untuk sistem causal LTI dengan menunjukkan ROC Rajah kutub-sifar bagi H(z) untuk persamaan berikut.*

*(Gunakan ciri Linearity dan Time delay untuk mendapatkan fungsi sistem H(z) yang bersamaan dengan Y(z)/X(z).)*

$$y[n] - 3\,y[n-1] + 2y[n-2] = x[n].$$

[20 marks]

*[20 markah]*





**QUESTION 2**

***SOALAN 2***

CLO3 C4

Discrete Fourier Transform (DFT) is a mathematic operation to change the N-sample discrete signal to the same frequency samples and is defined as,

$$X(k) = \sum_{n=0}^{N-1} x[n]e^{-j2\pi nk/N}$$

Draw the real and imaginary diagram of the sequence x[n] = {1,2,3,4} after being transformed using the above definition.

*Jelmaan Diskrit Fourier (DFT) adalah operasi matematik untuk mengubah isyarat diskrit N-sample kepada sampel yang mempunyai frekuensi yang sama dan didefinisikan sebagai,*

$$X(k) = \sum_{n=0}^{N-1} x[n]e^{-j2\pi nk/N}$$

*Lukiskan rajah komponen real dan imaginary bagi jujukan x[n] = {1,2,3,4} yang telah dijelmakan menggunakan definisi di atas.*

[20 marks]

*[20 markah]*

**SOALAN TAMAT**

## Energy and Power of Signal

$$E_x = \int_{-T/2}^{T/2} x(t)x^*(t)dt = \int_{-T/2}^{T/2} |x(t)|^2\, dt$$

$$P_x = \frac{1}{T}\int_{-T/2}^{T/2} x(t)x^*(t)dt = \frac{1}{T}\int_{-T/2}^{T/2} |x(t)|^2\, dt = \frac{1}{T}E_x$$

## Trigonometric of Signal in terms of Complex Exponential of Signal

$$x(t) = \cos\omega_1 t = \frac{e^{j\omega_1 t} + e^{-j\omega_1 t}}{2}$$

$$x(t) = \sin\omega_1 t = \frac{e^{j\omega_1 t} - e^{-j\omega_1 t}}{2j}$$

## Complex Exponential Fourier Series

$$f(t) = \sum_{n=-\infty}^{\infty} C_n\, e^{jn\omega t} \qquad C_n = \frac{1}{T}\int_0^T f(t)e^{-jn\omega t}dt$$

$$\int \cos at\,dt = \frac{1}{a}\sin at$$

$$\int \sin at\,dt = -\frac{1}{a}\cos at$$

$$\int t\cos at\,dt = \frac{1}{a^2}\cos at + \frac{1}{a}t\sin at$$

$$\int t\sin at\,dt = \frac{1}{a^2}\sin at - \frac{1}{a}t\cos at$$

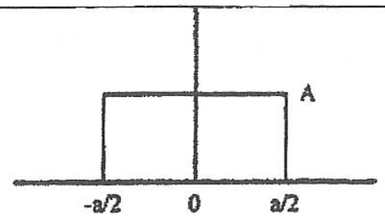
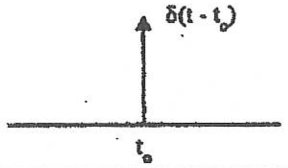
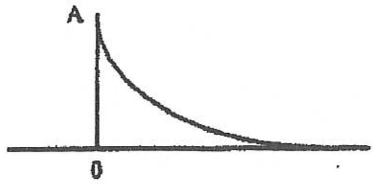
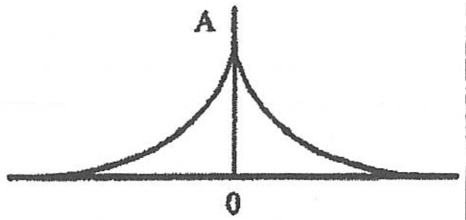
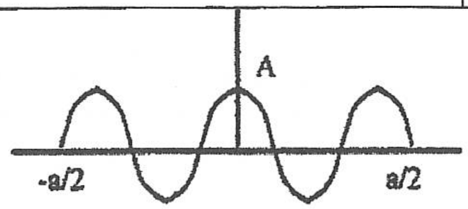
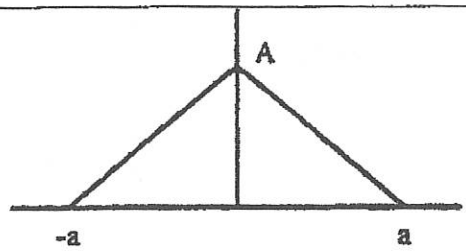
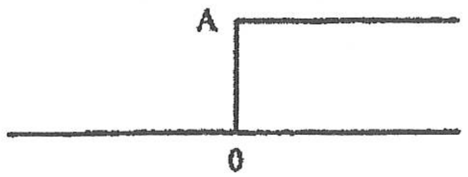
$$\int e^{-at}dt = \frac{e^{-at}}{-a}$$



## Properties Of Fourier Transform

| Theorem | Jika $F[f(t)] = F(\omega)$, maka: |
|---|---|
| Definition | $F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$ <br> $f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$ |
| Linearity | $F[af_1(t) + bf_2(t)] = aF_1(\omega) + bF_2(\omega)$ |
| Symmetry | $F(\omega) = 2\int_0^{\infty} f(t)\cos\omega t\,dt$ : f(t) even <br> $F(\omega) = -2j\int_0^{\infty} f(t)\sin\omega t\,dt$ : f(t) odd |
| Time Shifting | $F\, f(t-a) = F(\omega)e^{-j\omega a}$ |
| Time Scaling | $F\, f(at) = \frac{1}{\lvert a\rvert}F\left(\frac{\omega}{a}\right)$ |
| Magnitude Scaling | $F\, a\, f(t) = a\, F(\omega)$ |
| Frequency Shifting (or Amplitude Modulation) | $F\, f(t)e^{j\omega_o t} = F(\omega - \omega_o)$ <br> $F\, f(t)\cos\omega_o t = \frac{1}{2}[F(\omega-\omega_o) + F(\omega+\omega_o)]$ <br> $F\, f(t)\sin\omega_o t = \frac{1}{2}j[F(\omega-\omega_o) - F(\omega+\omega_o)]$ |
| Time differentiation | $F\left[\frac{d^n}{dt^n}f(t)\right] = (j\omega)^n F(\omega)$ |
| Convolution in $t$ <br> Convolution in $\omega$ | $F^{-1}[F_1(\omega)F_2(\omega)] = \int_{-\infty}^{\infty} f_1(\tau)f_2(t-\tau)d\tau$ <br> $F[f_1(t)f_2(t)] = \frac{1}{2\pi}\int_{-\infty}^{\infty} F_1(\lambda)F_2(\omega-\lambda)d\lambda$ |
| Reversal | $F\, f(-t) = F^*(\omega) = F(-\omega)$ |
| Duality | $F(t) = 2\pi f(-\omega)$ |
| Time Coefficient | $F\, t^n f(t) = (j)^n \frac{d^n F(\omega)}{d\omega^n}$ |

## Fourier Transform Pair

| | | |
|---|---|---|
| Pulse<br>$f(t) = A\,u\left(t+\frac{a}{2}\right) - A\,u\left(t-\frac{a}{2}\right)$ |  | $A\,a\,\text{sinc}\left(\frac{\omega a}{2}\right)$ |
| Impulse<br>$\delta(t - t_o)$ |  | $e^{-j\omega t_o}$ |
| Decaying exponential<br>$A\,e^{-at}\,u(t)$ |  | $\frac{A}{a + j\omega}$ |
| Symmetric decaying exponential<br>$A\,e^{-a\lvert t\rvert}$ |  | $\frac{2\,aA}{a^2 + \omega^2}$ |
| Tone burst (gated cosine)<br>$A\,f(t)\cos\omega_o t$ |  | $\frac{Aa}{2}\left[\text{sinc}\,(\omega - \omega_o) + \text{sinc}\,(\omega + \omega_o)\right]$ |
| Sawtooth |  | $A\,a\,\text{sinc}^2\left(\frac{\omega a}{2}\right)$ |
| Step input<br>$A\,u(t)$ |  | $A\left[\pi\,\delta(\omega) + \frac{1}{j\omega}\right]$ |



## Fourier Transform Pairs

| $f(t)$ | $F(\omega)$ |
|---|---|
| $\delta(t)$ | $1$ |
| $1$ | $2\pi\delta(\omega)$ |
| $u(t)$ | $\pi\delta(\omega) + \frac{1}{j\omega}$ |
| $u(t+\tau) - u(t-\tau)$ | $2\frac{\sin\omega\tau}{\omega}$ |
| $\lvert t\rvert$ | $\frac{-2}{\omega^2}$ |
| $\text{sgn}(t)$ | $\frac{2}{j\omega}$ |
| $e^{-at}u(t)$ | $\frac{1}{a+j\omega}$ |
| $e^{at}u(-t)$ | $\frac{1}{a-j\omega}$ |
| $t^n e^{-at}u(t)$ | $\frac{n!}{(a+j\omega)^{n+1}}$ |
| $e^{-a\lvert t\rvert}$ | $\frac{2a}{a^2+\omega^2}$ |
| $e^{j\omega_0 t}$ | $2\pi\delta(\omega - \omega_0)$ |
| $\sin\ \omega_0 t$ | $j\pi[\delta(\omega+\omega_0) - \delta(\omega-\omega_0)]$ |
| $\cos\ \omega_0 t$ | $\pi[\delta(\omega+\omega_0) + \delta(\omega-\omega_0)]$ |
| $\sin(\omega t + \theta)$ | $\frac{s\sin\theta + \omega\cos\theta}{s^2+\omega^2}$ |
| $\cos(\omega t + \theta)$ | $\frac{s\cos\theta - \omega\sin\theta}{s^2+\omega^2}$ |
| $e^{-at}\sin\omega_0 t u(t)$ | $\frac{\omega_0}{(a+j\omega)^2 + \omega_0^2}$ |
| $e^{-at}\cos\omega_0 t u(t)$ | $\frac{a+j\omega}{(a+j\omega)^2 + \omega_0^2}$ |

Properties of the Laplace Transform

| Property | $f(t)$ | $F(s)$ |
|---|---|---|
| Linearity | $a_1f_1(t)+a_2f_2(t)$ | $a_1F_1(s)+a_2F_2(s)$ |
| Scaling | $f(at)$ | $\frac{1}{a}F(\frac{s}{a})$ |
| Time shift | $f(t-a)u(t-a)$ | $e^{-as}F(s)$ |
| Frequency shift | $e^{-at}f(t)$ | $F(s+a)$ |
| Time differentiation | $\frac{df}{dt}$ | $sF(s)-f(0^-)$ |
| | $\frac{d^2f}{dt^2}$ | $s^2F(s)-sf(0^-)-f'(0^-)$ |
| | $\frac{d^3f}{dt^3}$ | $s^3F(s)-s^2f(0^-)-sf'(0^-)-f''(0^-)$ |
| | $\frac{d^nf}{dt^n}$ | $s^nF(s)-s^{n-1}f(0^-)-s^{n-2}f'(0^-)-...-f^{n-1}(0^-)$ |
| Time integration | $\int_0^t f(t)dt$ | $\frac{1}{s}F(s)$ |
| Frequency differentiation | $tf(t)$ | $-\frac{d}{ds}F(s)$ |
| Frequency integration | $\frac{f(t)}{t}$ | $\int_s^\infty F(s)ds$ |
| Time periodicity | $f(t)=f(t+nT)$ | $\frac{F_1(s)}{1-e^{-sT}}$ |
| Initial value | $f(0^+)$ | $\lim_{s\to\infty} sF(s)$ |
| Final value | $f(\infty)$ | $\lim_{s\to 0} sF(s)$ |
| Convolution | $f_1(t)*f_2(t)$ | $F_1(s)F_2(s)$ |



**Laplace Transform Pairs**

| $f(t)$ | $F(s)$ |
|---|---|
| $\delta(t)$ | $1$ |
| $u(t)$ | $\frac{1}{s}$ |
| $e^{-at}$ | $\frac{1}{s+a}$ |
| $t$ | $\frac{1}{s^2}$ |
| $t^n$ | $\frac{n!}{s^{n+1}}$ |
| $te^{-at}$ | $\frac{1}{(s+a)^2}$ |
| $t^ne^{-at}$ | $\frac{n!}{(s+a)^{n+1}}$ |
| $\sin\ \omega t$ | $\frac{\omega}{s^2+\omega^2}$ |
| $\cos\ \omega t$ | $\frac{s}{s^2+\omega^2}$ |
| $\sin(\omega t+\theta)$ | $\frac{s\sin\theta+\omega\cos\theta}{s^2+\omega^2}$ |
| $\cos(\omega t+\theta)$ | $\frac{s\cos\theta-\omega\sin\theta}{s^2+\omega^2}$ |
| $e^{-at}(\sin\omega t)$ | $\frac{\omega}{(s+a)^2+\omega^2}$ |
| $e^{-at}(\cos\omega t)$ | $\frac{s+a}{(s+a)^2+\omega^2}$ |
| $\sinh(at)$ | $\frac{a}{s^2-a^2}$ |

*Defined for $t\geq 0$, $f(t)=0$ for $t<0$

## Z-Transform Pairs

| $x(t)$ | $X(s)$ | $X(z)$ |
|---|---|---|
| 1. $\delta(t) = \begin{cases} 1 & t = 0, \\ 0 & t = kT, k \neq 0 \end{cases}$ | 1 | 1 |
| 2. $\delta(t - kT) = \begin{cases} 1 & t = kT, \\ 0 & t \neq kT \end{cases}$ | $e^{-kTs}$ | $z^{-k}$ |
| 3. $u(t)$, unit step | $1/s$ | $\frac{z}{z-1}$ |
| 4. $t$ | $1/s^2$ | $\frac{Tz}{(z-1)^2}$ |
| 5. $t^2$ | $2/s^3$ | $\frac{T^2 z(z+1)}{(z-1)^3}$ |
| 6. $e^{-at}$ | $\frac{1}{s+a}$ | $\frac{z}{z - e^{-aT}}$ |
| 7. $1 - e^{-at}$ | $\frac{a}{s(s+a)}$ | $\frac{(1 - e^{-aT})z}{(z-1)(z - e^{-aT})}$ |
| 8. $te^{-at}$ | $\frac{1}{(s+a)^2}$ | $\frac{Tze^{-aT}}{(z - e^{-aT})^2}$ |
| 9. $t^2 e^{-at}$ | $\frac{2}{(s+a)^3}$ | $\frac{T^2 e^{-aT} z(z + e^{-aT})}{(z - e^{-aT})^3}$ |
| 10. $be^{-bt} - ae^{-at}$ | $\frac{(b-a)s}{(s+a)(s+b)}$ | $\frac{z[z(b-a) - (be^{-aT} - ae^{-bT})]}{(z - e^{-aT})(z - e^{-bT})}$ |
| 11. $\sin \omega t$ | $\frac{\omega}{s^2 + \omega^2}$ | $\frac{z \sin \omega T}{z^2 - 2z \cos \omega T + 1}$ |
| 12. $\cos \omega t$ | $\frac{s}{s^2 + \omega^2}$ | $\frac{z(z - \cos \omega T)}{z^2 - 2z \cos \omega T + 1}$ |
| 13. $e^{-at} \sin \omega t$ | $\frac{\omega}{(s+a)^2 + \omega^2}$ | $\frac{(ze^{-aT} \sin \omega T)}{z^2 - 2ze^{-aT} \cos \omega T + e^{-2aT}}$ |
| 14. $e^{-at} \cos \omega t$ | $\frac{s+a}{(s+a)^2 + \omega^2}$ | $\frac{z^2 - ze^{-aT} \cos \omega T}{z^2 - 2ze^{-aT} \cos \omega T + e^{-2aT}}$ |
| 15. $1 - e^{-at}\left(\cos bt + \frac{a}{b} \sin bt\right)$ | $\frac{a^2 + b^2}{s[(s+a)^2 + b^2]}$ | $\frac{z(Az + B)}{(z-1)[z^2 - 2e^{-aT}(\cos bT)z + e^{-2aT}]}$<br>$A = 1 - e^{-aT} \cos bT - \frac{a}{b} e^{-aT} \sin bT$<br>$B = e^{-2aT} + \frac{a}{b} e^{-aT} \sin bT - e^{-aT} \cos bT$ |



## Properties of the Fourier Transform

| Property | Sequence | Fourier transform |
|---|---|---|
| | $x[n]$ | $X(\Omega)$ |
| | $x_1[n]$ | $X_1(\Omega)$ |
| | $x_2[n]$ | $X_2(\Omega)$ |
| Periodicity | $x[n]$ | $X(\Omega + 2\pi) = X(\Omega)$ |
| Linearity | $a_1 x_1[n] + a_2 x_2[n]$ | $a_1 X_1(\Omega) + a_2 X_2(\Omega)$ |
| Time shifting | $x[n - n_0]$ | $e^{-j\Omega n_0} X(\Omega)$ |
| Frequency shifting | $e^{j\Omega_0 n} x[n]$ | $X(\Omega - \Omega_0)$ |
| Conjugation | $x^*[n]$ | $X^*(-\Omega)$ |
| Time reversal | $x[-n]$ | $X(-\Omega)$ |
| Time scaling | $x_{(m)}[n] = \begin{cases} x[n/m] & \text{if } n = km \\ 0 & \text{if } n \neq km \end{cases}$ | $X(m\Omega)$ |
| Frequency differentiation | $nx[n]$ | $j\frac{dX(\Omega)}{d\Omega}$ |
| First difference | $x[n] - x[n-1]$ | $(1 - e^{-j\Omega})X(\Omega)$ |
| Accumulation | $\sum_{k=-\infty}^{n} x[k]$ | $\pi X(0)\delta(\Omega) + \frac{1}{1 - e^{-j\Omega}} X(\Omega)$<br>$\lvert\Omega\rvert \leq \pi$ |
| Convolution | $x_1[n] * x_2[n]$ | $X_1(\Omega) X_2(\Omega)$ |
| Multiplication | $x_1[n] x_2[n]$ | $\frac{1}{2\pi} X_1(\Omega) \otimes X_2(\Omega)$ |
| Real sequence | $x[n] = x_e[n] + x_o[n]$ | $X(\Omega) = A(\Omega) + jB(\Omega)$<br>$X(-\Omega) = X^*(\Omega)$ |
| Even component | $x_e[n]$ | $\text{Re}\{X(\Omega)\} = A(\Omega)$ |
| Odd component | $x_o[n]$ | $j\,\text{Im}\{X(\Omega)\} = jB(\Omega)$ |
| Parseval's relations | | |

$$\sum_{n=-\infty}^{\infty} x_1[n] x_2[n] = \frac{1}{2\pi} \int_{2\pi} X_1(\Omega) X_2(-\Omega)\, d\Omega$$

$$\sum_{n=-\infty}^{\infty} \lvert x[n] \rvert^2 = \frac{1}{2\pi} \int_{2\pi} \lvert X(\Omega) \rvert^2\, d\Omega$$

## Common Fourier Transform Pairs

| $x[n]$ | $X(\Omega)$ |
|---|---|
| $\delta[n]$ | $1$ |
| $\delta[n-n_0]$ | $e^{-j\Omega n_0}$ |
| $x[n]=1$ | $2\pi\delta(\Omega), \lvert\Omega\rvert \le \pi$ |
| $e^{j\Omega_0 n}$ | $2\pi\delta(\Omega-\Omega_0), \lvert\Omega\rvert, \lvert\Omega_0\rvert \le \pi$ |
| $\cos \Omega_0 n$ | $\pi[\delta(\Omega-\Omega_0)+\delta(\Omega+\Omega_0)], \lvert\Omega\rvert, \lvert\Omega_0\rvert \le \pi$ |
| $\sin \Omega_0 n$ | $-j\pi[\delta(\Omega-\Omega_0)-\delta(\Omega+\Omega_0)], \lvert\Omega\rvert, \lvert\Omega_0\rvert \le \pi$ |
| $u[n]$ | $\pi\delta(\Omega)+\frac{1}{1-e^{-j\Omega}}, \lvert\Omega\rvert \le \pi$ |
| $-u[-n-1]$ | $-\pi\delta(\Omega)+\frac{1}{1-e^{-j\Omega}}, \lvert\Omega\rvert \le \pi$ |
| $a^n u[n], \lvert a\rvert < 1$ | $\frac{1}{1-ae^{-j\Omega}}$ |
| $-a^n u[-n-1], \lvert a\rvert > 1$ | $\frac{1}{1-ae^{-j\Omega}}$ |
| $(n+1)a^n u[n], \lvert a\rvert < 1$ | $\frac{1}{(1-ae^{-j\Omega})^2}$ |
| $a^{\lvert n\rvert}, \lvert a\rvert < 1$ | $\frac{1-a^2}{1-2a\cos\Omega+a^2}$ |
| $x[n]=\begin{cases}1 & \lvert n\rvert \le N_1 \\ 0 & \lvert n\rvert > N_1\end{cases}$ | $\frac{\sin[\Omega(N_1+\frac{1}{2})]}{\sin(\Omega/2)}$ |
| $\frac{\sin Wn}{\pi n}, 0 < W < \pi$ | $X(\Omega)=\begin{cases}1 & 0 \le \lvert\Omega\rvert \le W \\ 0 & W < \lvert\Omega\rvert \le \pi\end{cases}$ |
| $\sum_{k=-\infty}^{\infty}\delta[n-kN_0]$ | $\Omega_0\sum_{k=-\infty}^{\infty}\delta(\Omega-k\Omega_0), \Omega_0=\frac{2\pi}{N_0}$ |