KOLEJ UNIVERSITI TEKNOLOGI TUN HUSSEIN ONN

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2006/07

NAMA MATAPELAJARAN	:	PEMPROSESAN ISYARAT DIGIT
KOD MATAPELAJARAN	:	BKE 4153
KURSUS	:	4 BKL
TARIKH PEPERIKSAAN	:	NOVEMBER 2006
JANGKAMASA	:	3 JAM
ARAHAN	:	JAWAB **LIMA (5)** SOALAN DARIPADA ENAM (6) SOALAN.

KERTAS SOALAN INI MENGANDUNGI 12 MUKA SURAT

SOALAN DALAM BAHASA MELAYU

S1 (a) Diberi x[n] ={ 1, 2, **4,** 5, 2}. Cari dan lakarkan isyarat berikut:

(i) bahagian genap dan ganjil isyarat x[n]
(ii) y[n] = x[-n+2]
(iii) isyarat langkah tentudalam dan lelurus tentudalam, h[n] = [0.5n-2]

(12 markah)

(b) Diberi isyarat g[n] seperti didalam Rajah S1(b), Nyatakan g[n] sebagai:

(i) Jujukan nombor.
(ii) Satu hasil tambah dedenyut teranjak
(iii) Satu hasil tambah langkah dan tanjakan

(6 markah)

(c) Lukiskan gambarajah blok untuk

(i) Pemprosesan isyarat analog.
(ii) Pemprosesan isyarat digital.

(2 markah)

S2 (a) Satu penapis sambutan dedenyut terhingga (FIR) mempunyai sambutan dedenyut yang di beri sebagai h[n] = n[u[n+2]-u[n-4]]. Cari sambutan penapis tersebut, y[n] kepada masukan x[n] = δ[n+1]+2δ[n]+2δ[n-1]+2δ[n-2]+2δ[n-3].

(8 markah)

(b) Cari pelingkaran berkala untuk isyarat x[n] = {**1**, 1, 2, 3} dan h[n] ={**2**, 3, 1, 1}

(8 markah)

(c) Cari pelingkaran y[n]=x[n]*h[n] untuk isyarat masukan $x[n] = (0.4)^n u[n]$ dan sambutan $h[n] = (0.4)^n \{u[n+3]-u[n-4]\}$

(4 markah)

S3 (a) Nyatakan dengan bantuan gambarajah tiga keadaan pensampelan.
Apakah frekuensi Nyquist.

(7 markah)

(b) Diberi

$Xp(t) = 5\cos(2\pi t) + \cos(20\pi t) + 6\sin(400\pi t) + 3\cos(6000\pi t) + 1\cos(12000\pi t)$.

Jika isyarat tersebut disampel pada 30Hz,

(i) Komponen manakah yang mengalami *aliasing* dan komponen manakah tidak?

(ii) Apakah isyarat analog yang sepadan untuk setiap komponen?

(ii) Apakah isyarat yang terjana daripada isyarat yang di sampel?

(iii) Berikan nilai frekuansi Nyquist jika semua isyarat hendak diperolehi?

Nyatakan frekuensi *aliasing* setiap komponen tersebut serta isyarat yang terjana. Apakah nilai frekuensi Nyquist jika semua isyarat hendak diperolehi.

(13 markah)

S4 (a) Kira Penjelmaan Fourier Diskret Masa (DTFT) bagi isyarat-isyarat berikut dan plotkan amplitud serta fasa spektra

(i) $x[n] = \delta[n+1] + \delta[n-1]$

(ii) $x[n] = u[n+1] - u[n-2]$

(iii) $x[n] = \cos\left(0.2\pi n + \frac{\pi}{4}\right)$

(9 markah)

(b) Kita mahu mengenalpasti komponen 21 Hz daripada N-sample Penjelmaan Fourier Diskret (DFT) bagi sesuatu isyarat. Kadar sampelan adalah 100 Hz dan hanya 128 sampel isyarat yang disediakan.

(i) Jika N=128, adakah komponen DFT bagi 21 Hz wujud? Jika tidak, apakah frekuensi terdekat kepada 21 Hz yang boleh dikenal pasti? Apakah indek DFT yang sepadan?

(5 markah)

(ii) Andaikan semua sample isyarat itu mesti digunakan dan sifar menebal dibenarkan, apakah nilai terkecil N yang boleh menghasilkan komponen DFT pada 21 Hz? Berapa banyak sifar menebal yang diperlukan? Apakah indek DFT yang menyebabkan komponen 21 Hz wujud?

(6 markah)

S5 (a) Pertimbangkan satu sistem $y[n]-\alpha y[n-1]=x[n]-\beta x[n-1]$

(i) Apakah nilai α dan β yang menyebabkan sistem itu stabil?
(ii) Apakah nilai α dan β yang menyebabkan sistem itu fasa minimum?
(iii) Apakah nilai α dan β yang menyebabkan sistem itu lulus semua?
(iv) Apakah nilai α dan β yang menyebabkan sistem itu fasa lelurus?

(8 markah)

(b) Rekabentuk penapis berikut (i.e cari $H(z)$) dengan menggunakan perletakan kutub-sifar.

(i) Penapis lulus jalur yang mempunyai frekuensi pusat $f_0 = 200$ Hz, 3 dB lebar jalur $\Delta f = 20$ Hz, gandaan sifar pada $f = 0$ dan $f = 400$ Hz dan frekuensi sampel 800 Hz.
(ii) Penapis takukan yang mempunyai frekuensi takukan pada 1 kHz, 3 dB jalur penahan 10 Hz dan frekuensi sampel 8 kHz.

(12 markah)

S6 Berikut adalah dua fungsi sistem yang berbeza tetapi mempunyai spesifikasi sambutan amplitud-frekuensi yang sama

(1) $$H(z)=\frac{b_0+b_1z^{-1}+b_2z^{-2}}{1+a_1z^{-1}+a_2z^{-2}}$$

di mana

$b_0 = 0.4981819$ $b_1 = 0.9274777$ $b_2 = 0.4981819$
$a_1 = -0.6744878$ $a_2 = 0.3633482$

(2) $$H(z)=\sum_{k=0}^{11} h(k)z^{-k}$$

di mana

$$h(0) = 0.54603280 \times 10^{-2} = h(11)$$
$$h(1) = -0.45068750 \times 10^{-1} = h(10)$$
$$h(2) = 0.69169420 \times 10^{-1} = h(9)$$
$$h(3) = -0.55384370 \times 10^{-1} = h(8)$$
$$h(4) = -0.63428410 \times 10^{-1} = h(7)$$
$$h(5) = 0.57892400 \times 10^{0} = h(6)$$

Bagi setiap penapis

(a) Nyatakan sama ada penapis itu sambutan dedenyut terhingga (FIR) atau sambutan dedenyut tak terhingga (IIR)

(2 markah)

(b) Lakarkan gambarajah blok yang mewakili operasi penapis tersebut dan tuliskan persamaan bezaan.

(6 markah)

(c) Tentukan:
(i) Bilangan pendaraban
(ii) Bilangan penambahan
(iii) Bilangan simpanan (pekali dan data)

Komen tentang keperluan pengiraan dan simpanan penapis tersebut.

(8 markah)

(d) Lakarkankan senibina perkakasan bagi penapis tersebut

(4 markah)

SOALAN DALAM BAHASA INGGERIS

Q1 (a) Let x[n] =={ 1, 2, **4**, 5, 2}. Find and sketch the following signal:

(i) Even and Odd parts of x[n]
(ii) y[n]=x[-n+2]
(iii) Step-interpolated and linearly interpolated signal h[n]=x[0.5n-2]

(12 marks)

(b) Given g[n] as in Figure Q1(b), state g[n] as:

(i) A numeric sequence.
(ii) A sum of shifted impulses.
(iii) A sum of steps and ramps.

(6 marks)

(c) Draw the block diagram of

(i) Analog signal processing.
(ii) Digital signal processing.

(2 marks)

Q2 (a) An finite impulse response (FIR) filter has an impulse response given by h[n] = n[u[n+2]-u[n-4]]. Find its response y[n] to the input x[n] = δ[n+1]+2δ[n]+2δ[n-1]+2δ[n-2]+2δ[n-3].

(8 marks)

(b) Find the periodic convolution of x[n] = {**1**, 1, 2, 3} and h[n] ={**2**, 3, 1, 1}

(8 marks)

(c) Find convolution y[n]=x[n]*h[n], for input signal x[n] = $(0.4)^n$u[n] and response h[n] = $(0.4)^n${u[n+3]-u[n-4]}

(4 marks)

Q3 (a) With the aid of diagram, state THREE (3) sampling conditions. What is the Nyquist frequency?

(7 marks)

(b) Given

$Xp(t)= 5\cos(2\pi t)+\cos(20\pi t)+6\sin(400\pi t)+3\cos(6000\,\pi t)+1\cos(12000\,\pi t)$.

If it is sampled at 30Hz.

(i) Which component experience *alising* and which is not?
(ii) What is the analog equivalent signal of each component?
(ii) What is the reconstructed sampled signal?
(iii) Give the Nyquist frequency value if all signals were to be recovered?

(13 marks)

Q4 (a) Compute the Discrete Time Fourier Transform (DTFT) of the following signals and plot their amplitude and phase spectra.

(i) $x[n]=\delta[n+1]+\delta[n-1]$
(ii) $x[n]=u[n+1]-u[n-2]$
(iii) $x[n]=\cos\left(0.2\pi n+\frac{\pi}{4}\right)$

(9 marks)

(b) We wish to identify the 21 Hz component from the N-sample Discrete Fourier Transform (DFT) of a signal. The sampling rate is 100 Hz and only 128 signal samples are available.

(i) If N=128, will there be a DFT component at 21 Hz? If not, what is the frequency closest to 21 kHz that can be identified? What DFT index does this corresponds to?

(5 marks)

(ii) Assuming that all signal samples must be used and zero padding is allowed, what is the smallest value of N that will result in a DFT component at 21 Hz? How many padding zeros will be required? At what DFT index will the 21 Hz component appear?

(6 marks)

Q5 (a) Consider the system $y[n]-\alpha y[n-1]=x[n]-\beta x[n-1]$.

(i) What values of α and β will the system be stable?
(ii) What values of α and β will the system be minimum phase?
(iii) What values of α and β will the system be allpass?
(iv) What values of α and β will the system be linear phase?

(8 marks)

(b) Design the following filters (i.e find $H(z)$) by pole-zero placement.

(i) A bandpass filter with a center frequency of $f_0 = 200$ Hz, a 3 dB bandwidth of $\Delta f = 20\,\text{Hz}$, zero gain at $f = 0$ and $f = 400\,\text{Hz}$ and a sampling frequency of 800 Hz.
(ii) A notch filter with a notch frequency of 1 kHz, a 3 dB stopband of 10 Hz and sampling frequency 8 kHz.

(12 marks)

Q6 The following system functions represent two different filters meeting identical amplitude-frequency response specifications:

(1) $$H(z)=\frac{b_0+b_1z^{-1}+b_2z^{-2}}{1+a_1z^{-1}+a_2z^{-2}}$$

where

$b_0 = 0.4981819$ $\quad$ $b_1 = 0.9274777$ $\quad$ $b_2 = 0.4981819$
$a_1 = -0.6744878$ $\quad$ $a_2 = 0.3633482$

(2) $$H(z)=\sum_{k=0}^{11} h(k)z^{-k}$$

where

$h(0)=0.54603280\times10^{-2}=h(11)$
$h(1)=-0.45068750\times10^{-1}=h(10)$
$h(2)=0.69169420\times10^{-1}=h(9)$
$h(3)=-0.55384370\times10^{-1}=h(8)$
$h(4)=-0.63428410\times10^{-1}=h(7)$
$h(5)=0.57892400\times10^{0}=h(6)$

For each filter

(a) State whether it is an Finite Impulse Response(FIR) or Infinite Impulse Response(IIR) filter

(2 marks)

(b) Sketch the block diagram that represent the filtering operation and write down the difference equation

(6 marks)

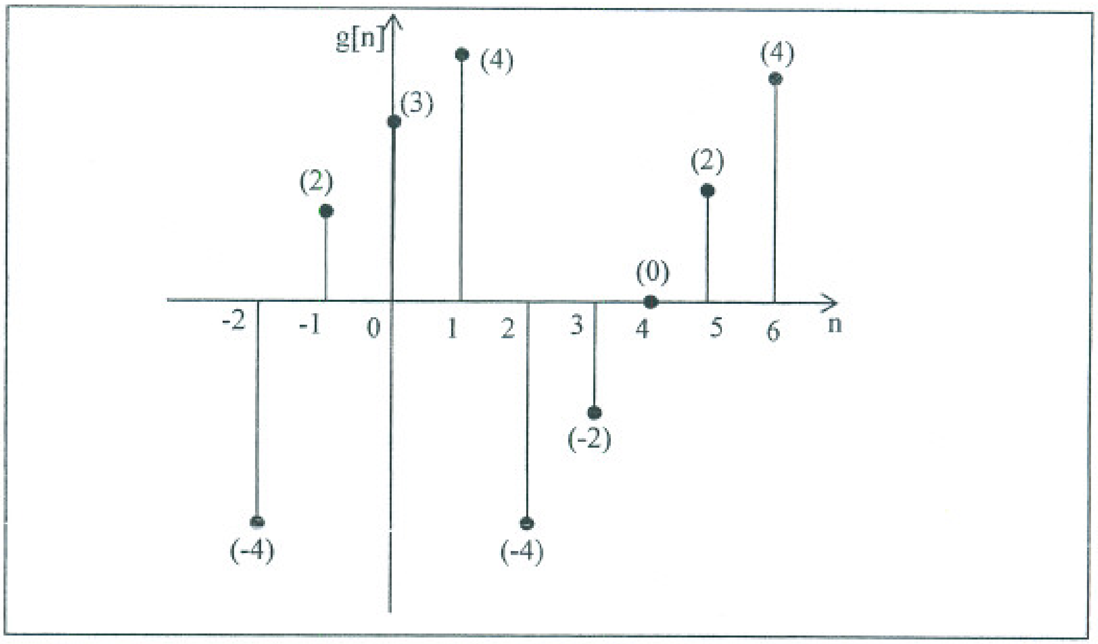
(c) Determine:
   (i) Number of multiplications
   (ii) Number of additions
   (iii) Number of storage (coefficients and data)

   Comment on computational and storage requirements

(8 marks)

(d) Sketch the hardware architecture for the filter

(4 marks)



Rajah S1(b) / Figure Q1(b)

Some Useful DTFT Pairs

Signal	The F-Form	The Ω Form
$\delta[n]$	1	1
$\alpha^n u[n], \lvert\alpha<1\rvert$	$\frac{1}{1-\alpha e^{-j2\pi F}}$	$\frac{1}{1-\alpha e^{-j\Omega}}$
$n\alpha^n u[n], \lvert\alpha<1\rvert$	$\frac{\alpha e^{-j2\pi F}}{(1-\alpha e^{-j2\pi F})^2}$	$\frac{\alpha e^{-j\Omega}}{(1-\alpha e^{-j\Omega})^2}$
$(n+1)\alpha^n u[n], \lvert\alpha<1\rvert$	$\frac{1}{(1-\alpha e^{-j2\pi F})^2}$	$\frac{1}{(1-\alpha e^{-j\Omega})^2}$
$\alpha^{\lvert n\rvert}, \lvert\alpha<1\rvert$	$\frac{1-\alpha^2}{1-2\alpha\cos(2\pi F)+\alpha^2}$	$\frac{1-\alpha^2}{1-2\alpha\cos(\Omega)+\alpha^2}$
1	$\delta[F]$	$2\pi\delta[\Omega]$
$\cos(2\pi nF_0)=\cos(n\Omega_0)$	$0.5[\delta(F+F_0)+\delta(F-F_0)]$	$\pi 0.5[\delta(\Omega+\Omega_0)+\delta(\Omega-\Omega_0)]$
$\sin(2\pi nF_0)=\sin(n\Omega_0)$	$j0.5[\delta(F+F_0)-\delta(F-F_0)]$	$j\pi 0.5[\delta(\Omega+\Omega_0)-\delta(\Omega-\Omega_0)]$
$2F_c \sin c(2nF_c)=\frac{\sin(n\Omega_c)}{n\pi}$	$rect\left(\frac{F}{2F_c}\right)$	$rect\left(\frac{\Omega}{2\Omega_c}\right)$
$u[n]$	$0.5\delta(F)+\frac{1}{1-e^{-j2\pi F}}$	$\pi\delta(\Omega)+\frac{1}{1-e^{-j\Omega}}$

Properties of the DTFT

Property	DT Signal	Result (F-Form)	Result (Ω-Form)
Folding	$x[-n]$	$X_p(-F) = X_p^*(F)$	$X_p(-\Omega) = X_p^*(\Omega)$
Time shift	$x[n-m]$	$e^{-j2\pi mF} X_p(F)$	$e^{-j\Omega m} X_p(\Omega)$
Frequency shift	$e^{j2\pi nF_0} x[n]$	$X_p(F - F_0)$	$X_p(\Omega - \Omega_0)$
Half-period shift	$(-1)^n x[n]$	$X_p(F - 0.5)$	$X_p(\Omega - \pi)$
Modulation	$\cos(2\pi nF_0)x[n]$	$0.5[X_p(F+F_0) + X_p(F-F_0)]$	$0.5[X_p(\Omega+\Omega_0) + X_p(\Omega-\Omega_0)]$
Convolution	$x[n] * y[n]$	$X_p(F)Y_p(F)$	$X_p(\Omega)Y_p(\Omega)$
Product	$x[n]y[n]$	$X_p(F) \otimes Y_p(F)$	$\frac{1}{2\pi}[X_p(\Omega) \otimes Y_p(\Omega)]$
Times-n	$nx[n]$	$\frac{j}{2\pi} \frac{dX_p(F)}{dF}$	$j\frac{dX_p(\Omega)}{d\Omega}$