NANYANG TECHNOLOGICAL UNIVERSITY
School of Electrical & Electronic Engineering

EE/IM4152 Digital Communications

Assignment (Sem 1, AY2016-2017)

The 2 questions below have been selected as the Assignment of the CONTINUOUS ASSESSEMENT. You are required to solve the problems yourself. Note that plagiarism will result in serious consequences. Write your solutions neatly on A4-size paper sheets with dark ball pens. Please hand in your solutions to the instructor (EEE-S1-B1b-62) by 5 pm on Friday, 09 September 2016.

1. A signal $g(t)$ band-limited to B Hz is sampled using a periodic pulse train $x_p(t)=\sum_{n=-\infty}^{\infty} x(t-nT_s)$, where $x(t)=\text{rect}\left(\frac{t-\tau/4}{\tau/2}\right)-\text{rect}\left(\frac{t+\tau/4}{\tau/2}\right)$. Note that $\tau=1/(16B)$ and the sampling period $T_s=1/(2B)$.

   (a) Plot the waveform $x(t)$ and find its Fourier transform $X(f)$.

   (10 marks)

   (b) Determine the Fourier coefficients $\{C_n\}$ of the periodic sampling function $x_p(t)$. Compute C_0, C_1 and C_2.

   (20 marks)

   (c) Determine the spectrum $\bar{G}(f)$ of the sampled-data signal $\bar{g}(t)=g(t)\times x_p(t)$. Can the signal $g(t)$ be recovered by passing $\bar{g}(t)$ through an appropriate low-pass filter (LPF)? If not possible, suggest an approach to recover the signal $g(t)$.

   (20 marks)

2. A signal $g(t)=20\,\text{sinc}(20t)$ is sampled using a periodic unit impulse train $\delta_{T_s}(t)=\sum_{n=-\infty}^{\infty}\delta(t-nT_s)$ at a sampling rate f_s of (i) 10 Hz and (ii) 20 Hz, where $f_s=1/T_s$.

   (a) Obtain the frequency-domain and time-domain representations of $g(t)$. Determine the bandwidth of $g(t)$ and its Nyquist sampling rate.

   (10 marks)

   (b) Sketch the spectrum of the sampled-data signal $\bar{g}(t)=g(t)\times\delta_{T_s}$ for each of the two sampling rates.

   (20 marks)

   (c) If the sampled-data signal $\bar{g}(t)$ is passed through an ideal low-pass filter (LPF) of bandwidth 10 Hz and gain $1/20$. Sketch the spectrum of the output signal $y(t)$ and determine $y(t)$ for each of the two sampling rates. Can we say that the signal $g(t)$ has been recovered in both cases?

   (20 marks)