XMUT310 Communication Engineering

Tutorial 4: Analog to Digital (on Sampling, Nyquist, Quantization, PCM etc)

Answers are provided for your convenience.

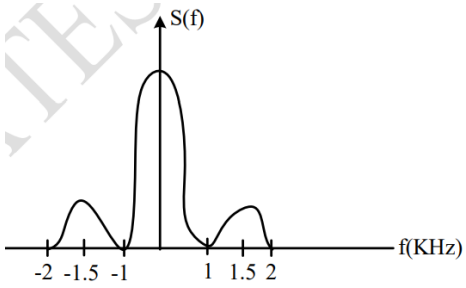
Most solutions can be found in Bilibili
https://www.bilibili.com/video/BV1V5411V7MN/ and
https://www.bilibili.com/video/BV1Vy4y1D7Jd/

Q1. A bandlimited signal is sampled at the Nyquist rate. The signal can be recovered by passing the samples through

(a) an RC filter
(b) an envelope detector
(c) a PLL
(d) an ideal low-pass filter with the appropriate bandwidth

(Answer: d)

Q2. A deterministic signal has the power spectrum given in figure. The minimum sampling rate needed to completely represent signal is



(a) 1 kHz
(b) 2 kHz
(c) 3 kHz
(d) 4 kHz

(Answer: b)

Q3. A signal has frequency components from 300 Hz to 1.8 KHz. The minimum possible rate at which the signal has to be sampled is _____.

(Answer: 3600 samples/second)

Q4. Increased pulse width in the flat top sampling leads to

(a) attenuation of high frequencies in reproduction
(b) attenuation of low frequencies in reproduction
(c) greater aliasing errors in reproduction

(d) no harmful effects in reproduction

(Answer: a)

Q5. A 1.0 kHz signal is flat top sampled at the rate of 1800 samples/sec and the samples are applied to an ideal rectangular LPF with cut-off frequency of 1100 Hz, then the output of the filter contains

(a) only 800 Hz component
(b) 800 Hz and 900 Hz components
(c) 800 Hz and 1000 Hz components
(d) 800 Hz, 900 Hz and 100 Hz components

(Answer: c)

Q6. The Nyquist sampling interval, for the signal sinc (700 t) + sinc (500 t) is

(a) 1/350 sec
(b) π/350 sec
(c) 1/700 sec
(d) π/175 sec

(Answer: c)

Q7. The Nyquist sampling frequency (in Hz) of a signal given by 6×10^4 sinc^2 $(400t) * 10^6$ sinc^3 $(100t)$ is

(a) 200
(b) 300
(c) 1500
(d) 1000

(Answer: b)

Q8. Four independent massages have bandwidths of 100 Hz, 100 Hz, 200 Hz and 400 Hz, respectively. Each is sampled at the Nyquist rate, and the samples are Time Division Multiplexed (TDM) and transmitted. The transmitted rate (in Hz) is

(a) 1600
(b) 800
(c) 400
(d) 200

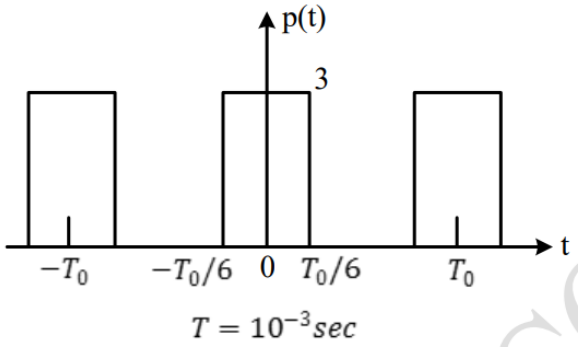
(Answer: a)

Q9. A signal $x(t)$ = 100 $\cos(24\pi \times 10^3)$ t is ideally sampled with a sampling period of 50 µsec and then passed through an ideal low pass filter with cutoff frequency of 15 kHz. Which of the following frequency is/are per present at the filter output?

(a) 12 kHz only

(b) 8 kHz only
(c) 12 kHz and 9 kHz
(d) 12 kHz and 8 kHz
(Answer: d)

Q10. Let $x(t)$ = 2 cos(800πt) + cos(1400πt). $x(t)$ is sampled with the rectangular pulse train shown in the figure. The only spectral components (in kHz) present in the sampled signal in the frequency range 2.5 kHz to 3.5 kHz are



(a) 2.7, 3.4
(b)3.3, 3.6
(c) 2.6, 2.7, 3.3, 3.4, 3.6
(d)2.7, 3.3

(Answer: d)

Q11. The Nyquist sampling rate for the signal $s(t)$ = sin(500πt)/πt × sin(700πt)/πt is given by

(a) 400 Hz
(b) 600 Hz
(c) 1200 Hz
(d)1400 Hz

(Answer: c)

Q12. An analog voltage in the range 0 to 8 V is divided in 16 equal intervals for conversion to 4-bit digital output. The maximum quantization error (in V) is _____.

(Answer: 0.25 V)

Q13. Compression in PCM refers to relative compression of

(a) higher signal amplitudes
(b) lower signal amplitudes
(c) lower signal frequencies
(d) higher signal frequencies

(Answer: a)

Q14. The signal to quantization noise ratio in an n-bit PCM system

(a) depends upon the sampling frequency employed
(b) is independent of the value of 'n'
(c) increasing with increasing value of 'n'
(d) decreases with the increasing value of 'n'

(Answer: c)

Q15. If the number bits per sample in a PCM system is increased from and n to (n+1), the improvement is signal to quantization nose ratio will be

(a) 3 dB
(b) 6 dB
(c) 2 n dB
(d) n dB

(Answer: b)

Q16. The bandwidth required for the transmission of a PCM signal increases by a factor of _____ when the number of quantization levels is increased from 4 to 64.

(Answer: 3)

Q17. The number of bits in a binary PCM system is increased from n to n+1. As a result, the signal quantization noise ratio will improve by a factor

(a) $(n + 1)/n$
(b) $2^{(n+1)/n}$
(c) $2^{2(n+1)/n}$
(d) Which is independent of n

(Answer: d)

Q18. In a PCM system with uniform quantization, increasing the number of bits from 8 to 9 will reduce the quantization noise power by a factor of

(a) 9
(b) 8
(c) 4
(d) 2

(Answer: c)

Q19. The peak to peak input to an 8 bit PCM coder is 2 volts. The signal power to quantization noise power ratio (in dB) for an input of 0.5 cos $\omega_m t$ is

(a) 47.8
(b) 49.8
(c) 95.6
(d) 99.6

(Answer: b)

Q20. A signal is sampled at 8 kHz and is quantized using 8-bit uniform quantizer. Assuming SNR_q for a sinusoidal signal, the correct statement for PCM signal with a bit rate of R is

(a) R = 32 $kbps$, $SNRq$ = 25.8 dB
(b) R = 64 $kbps$, $SNRq$ = 49.8 dB
(c) R = 64 $kbps$, $SNRq$ = 55.8 dB
(d) R = 32 $kbps$, $SNRq$ = 49.8 dB

(Answer: b)

Q21. In a baseband communication link, frequencies up to 3500 Hz are used for, signaling. Using a raised cosine pulse with 75% excess bandwidth and for no inter-symbol interference, the maximum possible signaling rate due to the excess bandwidth in symbols per second is

(a) 1750
(b) 2625
(c) 4000
(d) 5250

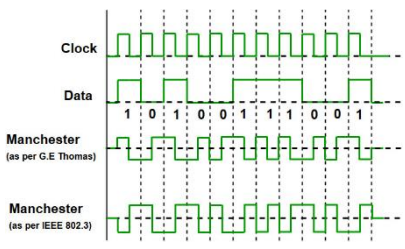
(Answer: d)

Q22. An analog signal is band-limited to 4 KHz, sampled at the Nyquist rate and the 4 samples levels are assumed to be independent and equally probable. If we transmit two quantized samples per second, the information rate is

(a) 1 bit/sec
(b) 2 bits/sec
(c) 3 bits/sec
(d) 4 bits/sec

(Answer: d)

Q23. In Ethernet when Manchester encoding is used, the bit rate is:
(a) Half the baud rate.
(b) Twice the baud rate.
(c) Same as the baud rate.
(d) None of the above



(Answer: a)