Course: Fundamentals of Telecommunication Systems		Number: ELEC363/2	Section: U
Examination: Final	Date: April 28, 2009	Time: 3 Hours	# of pages: 2 +table
Instructor: Dr. M.R. Soleymani			
Books and Materials: Only one formula sheet allowed			
Calculators: Allowed (standard type)			
Special Instructions: Try all 8 questions. Make reasonable assumptions if necessary.			

1) Design an Armstrong indirect FM modulator to modulate signals with a bandwidth of 5 kHz. with a carrier frequency of 91.2 MHz. and $\Delta f = 75\,\text{kHz}$. We have a narrow band FM modulator that modulates the 5 kHz. signal with a carrier frequency of 1 MHz. and $\beta = 0.02$, and a local oscillator with an adjustable frequency in the range of 20 to 30 MHz. You should draw the block diagram and give the specification of each block and frequency as well as Δf at each point (8Marks).
2) Assume that audio signals band-limited to15 kHz.are sampled at a rate 47% above the Nyquist rate and quantized with 65,536 levels.
    a) How many minutes of stereo music can be stored on a CD-ROM if the capacity of the CD-ROM is 700 Mbytes? (4 Marks)
    b) What is the signal to quantization noise ratio if the audio signal's peak to *rms* value is 4? (3 Marks)
3) Eight compressed digital video streams each with a rate of 5 Mbps are time multiplexed. The frame duration is 0.5 ms and there are 12 bytes for synchronization, 8 bytes for signalling and 80 bytes for error correction per frame.
    a) Calculate the number of bits per frame (3 Marks)
    b) Calculate the overall bit rate of the resulting multiplexed signal (2 Marks).
    c) Calculate the effective (useful) bit rate of the multiplexed signal and the efficiency (2 Marks).

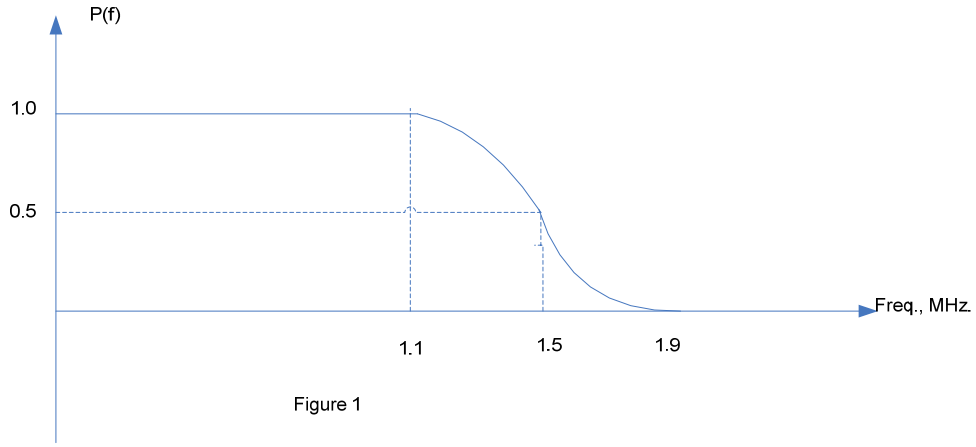

Figure 1

4) A pulse $p(t)$ has the spectrum shown in Figure 1. It satisfies the no ISI criterion.
    a) Find the maximum rate at which binary data can be transmitted using this pulse. (3 Marks).
    b) What is the roll-off factor? (3 Marks)

c) What is the answer to part (a) if instead of binary 16-ary signalling were used (2 Marks).

5) Two computers are connected with 50 feet of lossy cable whose attenuation is 1 dB/ft. Data is transmitted from one computer to the other at rate of 1 Mbps using polar signalling. The detection error probability is required to be less than 10^{-10}. The rms. value of the noise at the receiver input is $100\ \mu V$.
   a) Determine the minimum required pulse amplitude, power and energy per bit at the receiver input (6 Marks).
   b) Determine the minimum signal power that must be transmitted (3 Marks).
   c) Determine the average number of errors in one day (2 Marks).

6) In a binary transmission system using duobinary pulses, the sample values of the received pulses are:

$$1, 2, 0, 0, 0, -2, 0, 0, -2, 0, 2, 0, 0, -2, 0,\ 2,\ 2, 0, -2$$

   a) Determine whether there is any error in the transmission (explain) (2 Marks)
   b) Can you guess the correct transmitted bit sequence assuming that having more than one error is very unlikely. (2 Marks)

7) Consider an FM communication system with $\beta = 3$. The input to the modulator $m(t)$ is Gaussian and band-limited to 15 kHz. and 3σ loading is used. The channel noise is white with a power spectral density of $S_n(\omega) = 10^{-10}$. The output of the demodulator is $\alpha k_f m(t)$ where $\alpha = 10^{-4}$. If the output SNR is 30 dB,
   a) Find the received signal power S_i. (3 Marks)
   b) Find the output signal power S_o. (2 Marks)
   c) Find the output noise power N_o. (2 Marks)

8) A zero-mean Gaussian signal with power σ^2 is quantized with a quantizer with levels in the range of -4σ to $+4\sigma$, i.e., the samples outside of this range are quantized with either the lowest or the highest level. What is the probability that a sample falls outside this range? (3 Marks)