FIJI NATIONAL UNIVERSITY

College of Engineering, Science and Technology (CEST)
School of Electrical & Electronic Engineering

BACHELOR IN ENGINEERING (ELECTRICAL & ELECTRONICS), YEAR 3

EEE750 – DIGITAL COMMUNICATION

FINAL EXAMINATION - SEMESTER 1

DAY/DATE: FRIDAY - June 16th, 2017. TIME: 9.00pm - 12:10pm.

INSTRUCTIONS TO CANDIDATES:

1. You are allowed 10 minutes Extra reading time during which you are NOT to write.
2. Begin each question on a fresh page and use both sides of the sheet.
3. Write your candidate – number at the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string.
5. For all sheets of paper on which rough/draft work has been done, cross it through and ATTACH to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. You are to answer any FIVE (5) of the SEVEN (7) questions in this examination. Each question carry equal marks.
8. Only Non-programmable calculators are permitted into the examination hall.
9. CANDIDATES ARE NOT ALLOWED TO EXCHANGE NOTES OR MATERIALS DURING THE COURSE OF THIS EXAMINATION.

QUESTION 1 PRINCIPLES OF DIGITAL DATA COMMUNICATION

(a) The present days digital communication system is comprised of several sub-systems. With the help of a diagram show these sub-systems as integral parts of the whole system and conceptually outline their purposes.

(12 marks)

(b) Line coding is very important in digital communication. Give two reasons in support of this statement. The following polynomial $x^{12}\,x^{11} + x^{10} + x^{7} + x^{5} + x^{2} + x + x^{0}$ represents the information that is to be sent to a user in a digital communication system. Draw the square pulse waveforms for binaries before transmission over the channel in the following formats: on-off, polar on-off, pseudoternary code, non-polar non-return-to-zero and polar non-return-to-zero. Which of these codes is the most power efficient?

(8 marks)

[Total: 20 Marks]

QUESTION 2 INFORMATION THEORY & NOISE

(a) (i) Derive that the average information per message interval is represented by H is $\sum_{k=1}^{M} p_k \log_2 p_k^{-1}$

(ii) One of the possible messages Q_1 to Q_5 having probabilities of ½, ¼, ⅛, $^1/_{16}$, $^1/_{16}$ respectively is being transmitted over a channel. Give its entropy.

(7 marks)

(b) (i) In information theory, what does the expression $\lim_{P \to 0} \log 1/p = 0$ mean?

(ii) A transmitting station generated an analog signal which is band-limited to B hertz, sampled at Nyquist rate and the samples are quantized into 4-levels. The levels are assumed to be independent with probability occurrences as 1/8, 2/8, 3/8, 2/8. Find the information rate of the source. What was the condition for the Shannon's Theorem on channel capacity to transmit information with an arbitrarily small probability of errors?

(7 marks)

(c) Speech is digitised at 64 kilobits per second. How could this bit-stream be efficiently transmitted over a channel of 48 kilohertz bandwidth centred on 100 kilohertz? According to the Shannon-Hartley Law, what signal-to-noise ratio would be required to ensure that arbitrarily low bit-error rates are achievable for this transmission.

(6 marks)

[Total: 20 Marks]

QUESTION 3 MODULATION & POWER SPECTRAL ANALYSIS

(a) What effect does modulation have on the spectrum, of signal g(t), and how does the modulating signal frequency, f_o, affect this effect. Show that the Energy Spectrum Density (ESD), of the modulated signal is $\Psi_\varphi(f) = ¼\,\Psi_g(f + f_o) + ¼\,\Psi_g(f - f_o)$.

Name the condition/s for non-overlapping of modulated signals. Sketch neatly the energy spectral densities waveforms of both the modulating and modulated signals. Compare the area of the modulating signal with that of the modulated signal and state the magnitude of the baseband frequency if it is band-limited to B hertz. What causes the energy of the modulated signal to drop?

(11 marks)

(b) An ideal differentiator, d/dt, is fed with a noise signal $n_i(t)$ with power spectral density, $S_{ni}(f) = K$. Draw a lock diagram to represent this differentiator, determine the power spectral density and power of the output noise, $n_o(t)$. Also draw the waveforms of the spectral densities of the input noise and output noise. Do label clearly.

(9 marks)

[Total: 20 Marks]

QUESTION 4 PULSE CODE MODULATION

(a) (i) Explain clearly and show by graphical diagram the quantisation of sampled analog signal, m(t), and indicate the range in which the amplitude lie. If the level (L) of quantisation is 16 determine the voltage level of each division?

(ii) Comment on the main objectivity in telephone systems and so if the communication is band-limited to 3.4 kilohertz what happens to the information above that. Calculate the sampling frequency and justify the result. What would be the level of quantisation and give a reason/s for your choice.?

(8 marks)

(b) Analyse the pulse code modulation (PCM) scheme and state the weakness/es. How does differential pulse code modulation (DPCM) differ from the normal pulse code modulation and what is the significance of this difference? What actually is transmitted in DPCM scheme and how is it produced? What are the significant factors at the receiver to help reconstruct the message?

(6 marks)

(c) Produce a normal scrambler diagram and fed it with a data stream S, $s^{14} + s^{12} + s^{10} + s^{8} + s_2 + s + s^{0}$. Find the scrambler output named T and state your assumptions in this process.

(6 marks)

[Total: 20 Marks]

QUESTION 5 COMPANDER, SYNCHRONISATION AND PULSE SHAPING

(a) Comment on the significance of the μ – Law and alpha-law algorithm in companding schemes and their consequences in modem digital communication systems even with either schemes.

(8 marks)

(b) (i) In digital communication Intersymbol interference (ISI) is always a problem. Use the Nyquist first criterion to eliminate ISI in received data signals and suggest the required bandwidth given that T_b is the time interval. Use graphs to demonstrate this zero ISI.
(ii) Which pulse satisfies the Nyquist criterion in this problem and graph this pulse up to +/- $3/R_b$. Provide the Fourier transform of this pulse, its bandwidth and draw its waveform.

(12 marks)

[Total: 20 Marks]

QUESTION 6 DIGITAL CARRIER SYSTEMS

(a) Make brief analytical account of the significance of frequency translation in digital communication. Given that a sinusoidal high frequency signal is the carrier and a digital baseband show the frequency translation in waveforms and label each waveform with it's trigonometric identity.

(6 marks)

(b) Briefly account for the Quadrature Amplitude Modulation, QAM. Illustrate the geometric constellation of the phase shift keying (PSK) symbols on a signal space for M-ary values for 2^1, 2^2, 2^3 and 2^4 respectively.

(6 marks)

(c) State from an analysis standpoint the significance of the eye-diagram in digital communication? Show this signal analysis by producing and analyzing an eye diagram given that the baseband signal at the output channel is $y(t) = \Sigma a_k p(t - kT_b)$. Name the equipment that can help in generating an eye diagram in the laboratory.

(8 marks)

[Total: 20 Marks]

QUESTION 7 ERROR DETECTION AND CORRECTION

(a)Convolution codes is a typical coding technique in communication, how is it done? Use a diagram to support or demonstrate this process for a n shift registers.

(5 marks)

(b) The cyclic redundancy check (CRC) is one of the powerful error-detection schemes in digital communication. Briefly explain it's mathematical technique, mention the success rate and give the algebraic expression of the transmitted polynomial in terms of :
M(x) be a k - bit number; G(x) be an (n + 1) - bit number; R(x) be an n - bit number such that k > n;
Q(x) is the generated quotient.

(7 marks)

(c) How can an error-free digital communication be achieved? Comment on the forward error correcting codes. For a (7,4) cyclic code and given a polynomial (M(x)) as 1100 and a generator polynomial (G(x)) as 1011, determine the block check code (BCC) and give the transmitted information. How can the receiver tell that the received message is accurate?

(8 marks)

[Total: 20 Marks]

The End