FIJI NATIONAL UNIVERSIT

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 17th, 2016. 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

(a) With the help of a diagram show a digital communication system and the components position as an integral part of the system. Do clearly and conceptually outline each component functionalities.

(12 marks)

(b) The line coded information 111001010111 is about to be sent to a receiver in a digital communication system. Show the waveforms in binary cases for the purpose of transmission over the channel in the following formats: return to zero (RZ), polar on-off, bipolar code, unipolar non-return-to-zero (NRZ) and polar non-return-to-zero. Which of these codes is the most power efficient one?

(6 marks)

(c) The characteristics of channels are important in digital communication. What are these characteristics?

(2 marks)

[Total: 20 Marks]

QUESTION 2

(a) (i) Derive that in information theory, entropy represented by H is given as $\sum_{k=1}^{M} p_k \log_2 p_k^{-1}$

(ii) One of the possible messages Q_1 to Q_5 having probabilities as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ respectively is transmitted over a channel. What can be the average information?

(6 marks)

(b) An analog signal is band limited to B hertz sampled at Nyquist criterion and the quantization is at 4-ary-levels. The levels are assumed to be independent with probability of 1/8, 2/8, 3/8, 2/8. Find the information rate of the source. What is the condition for the Shannon's Theorem on channel capacity to transmit information with an arbitrarily small probability of errors?

(6 marks)

(c) (i) The capacity of a Shannon- Hartly channel is $C = B \log_2(1 + S/N)$. Given that the noise power is ηB show that the channel capacity $C = 1.44S/\eta$. What does this theorem indicate?
(ii) Provide the capacity of a standard telephone channel ranging from 0.3 to 3.4 kilohertz with signal noise of 32dB.

(8 marks)

[Total: 20 Marks]

QUESTION 5

(a) How significant are the μ – Law and A-law algorithms in companding schemes? Make brief discussion and state their effects on a global scale in modern digital communication systems.

(7 marks)

(b) (i) Intersymbol interference (ISI) is a problem in digital communication. Use the Nyquist first criterion to eliminate ISI in received data signals and suggest the required bandwidth given that T_b is equal to the inverse of bit rate, R_b. Use graphs to demonstrate this zero ISI.

(ii) Find the pulse that satisfies the Nyquist criterion and graph this pulse up to +/- $3T_b$. Give the Fourier Transform of this pulse, its bandwidth and draw its waveform.

(8 marks)

(c) A signal g(t) band-limited to 3000 hertz is sampled at $33\frac{1}{3}$ per cent above the Nyquist rate. The maximum acceptable error in the sampled amplitude is 0,5 per cent of the peak amplitude. The quantized samples are coded. Find the minimum bandwidth of the channel required to transmit the encoded signal and determine the minimum band width for 24 channels in a time division multiplexed signal.

(5 marks)

[Total: 20 Marks]

QUESTION 6

(a) Make brief analytical account of the significance of shifting frequency in digital communication. Give the trigonometric identities and draw the respective waveforms of a carrier, baseband and the modulated signal for amplitude shift keying in digital communication.

(6 marks)

(b) (i) Give a brief account of 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, 4, 8 and 16 respectively.

(ii) Give a brief account of the significance of the constellation diagram in digital modulation scheme and how to interpret the received signal by using the constellation diagram.

(9 marks)

(c) State the significance of the eye-diagram in digital communication from an analysis standpoint? Illustrate this signal analysis by analyzing an eye diagram given that the baseband signal at the output channel is $y(t) = \Sigma a_k\, p(t - kT_b)$.

(5 marks)

[Total: 20 Marks]

QUESTION 3

(a) Signal modulation shifts the signal spectrum, G(f), to the left and to the right by the modulating signal frequency, f_o. Show that the Energy Spectrum Density (ESD), of the modulated signal is:

$$\Psi_\phi(f) = 0.25\Psi_g(f + f_o) + 0.25\Psi_g(f - f_o),$$

State the condition for non-overlapping of modulated signals and draw the energy spectral densities waveforms of both signals (modulating and modulated).

(11 marks)

(b) An ideal differentiator, as in figure 1, is fed with a noise signal $n_i(t)$ with power spectral density, $S_{ni}(f) = K$. Give the power spectral density and power of the output noise, $n_o(t)$, and also draw the waveforms of the spectral densities of the input noise and output noise. Label clearly.

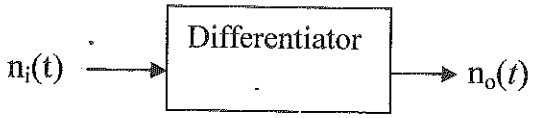

Figure 1

(9 marks)

[Total: 20 Marks]

QUESTION 4

(a) (i) Show and explain by graphical diagram the quantisation of sampled analog signal, m(t), and indicate the range in which the amplitude lies. Suppose that the level (L) of quantisation is 16 what would be the voltage of each division?

(ii) The desire in telephone communication is intelligibility rather than fidelity, so if only 3400hertz bandwidth is used what happens to the information above that. The sampling rate is 8000 hertz and is greater than the Nyquist rate, give a reason for this. What could be the level of quantisation and qualify your choice.?

(8 marks)

(b) How does the differential pulse code modulation improves the weaknesses in pulse code modulation in digital communication? Show also the significance of the Taylor's series in this improvement. If the k^{th} sample of a signal m(t) is m[k] show that the probable next sample is 2m[k] – m[k - 1].

(7 marks)

(c) A scrambler is fed a data stream S, 101010100000111. Assuming that the registers contain only zeros find the scrambler output named T.

(5 marks)

[Total: 20 Marks]

QUESTION 7

(a) In modern telecommunication systems the cyclic redundancy check (CRC) is one of the powerful error-detection schemes in digital communication. Explain briefly it's mathematical technique, success rate and produce 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 and Q(x) is the generated quotient.

(9 marks)

(b) (i) How can the system achieve an error-free digital communication? Briefly comment on the forward error correcting codes.
(ii) For a (7,4) cyclic code and given a polynomial (M(x)) as 1100 and a generator polynomial (G(x)) as $x^3 + x^1 + x^0$, determine the block check code (BCC) and show the transmitted information. How does the receiver know that there is no error?

(11marks)

[Total: 20 Marks]

The End

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FNU/E-5

EQP RECEIPT CHECKLIST FORM

Particulars		Details/Comments (To be filled by Unit Lecturer)	Tick if present on EQP (To be filled by exams staff)
Cover Page			
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College		~	
School		~	
Program		~	
Unit Code		~	
Unit Name		~	
Examination Period		~	
Duration of Examination		~	
Instructions		~	
Total Number of Pages		~ (4)	
Other Pages		~	
Footer	Page Number	~	
	Unit Code	~	
	Examination Period		
Last Page			
The End		~	
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Proper Print			
Examination Requirements (FNU/E-1)		~ calculator	
Moderator's Report (FNU/E-3)			
ERRS (Class List)			
Unit Coordinator/Principal Lecturer's Name			

DISPATCHED BY (SCHOOL REP)

NAME: _____

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24-May-2016

Fiji National University

Class Listing

School of Electrical & Electronics Engineering | Samabula | Semester1 | 2016

EEE750 Digital Communication NL

StudentID	Name	Status	Mon	Sponsor	Outstanding Fee
Bachelor of Engineering (Telecommunication & Netwo					
2006002744	Ashneel Arunesh Prasad	EA			
2012010501	Branden Basil Manerara	ER		Solomon Island Government - Full	8,473.00
2012001259	Inoke Seru Saumaki	EA			
2014119665	Munish Davneel Gounder	EA		Tertiary Education Loan Scheme (Existir	
2014120266	Munish Dhiraj Gounder	EA		Tertiary Education Loan Scheme (Existir	
2004003438	Ravinesh Prasad	EA			
2014120290	Ravitesh Michael Prasad	ER			2,693.00
2014121129	Semi Bulinavesi	EA		Tertiary Education Loan Scheme 2016 -	
		8		**Total Owing:**	**11,166.00**
	Total Count:	8		**Grand Total:**	**11,166.00**