FNU FIJI NATIONAL UNIVERSITY
College of Engineering, Science & Technology

DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE504 – ELECTRONIC COMMUNICATIONS SYSTEM.

FINAL EXAMINATION – SEMESTER 1 - 2016.

DURATION: 3 HRS

INSTRUCTIONS TO STUDENTS:

1. You are allowed 10 minutes **EXTRA** as reading time during which you are **NOT** to write.
2. Begin each answer 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 foolscap, graph paper, drawing paper, etc. in their correct sequence and secure well.
5. For all sheets of paper on which rough/draft work has been done, cross it through and attach to your answer scripts.
6. Show all workings where necessary
7. Diagrams and graphs can be drawn in pencil.
8. Non- programmable calculators are allowed.
9. **Attempt all questions in Sections A, B & C and 2 questions in Section D.**
10. Check your work before you leave the room!!

Section A: TRUE or FALSE **(10 marks)**

Attempt all questions in this section and write down your answers, either true or false in your answer sheet provided.

1. In Frequency Modulation (FM), the instantaneous value of the Carrier frequency changes in accordance with the frequency variations of the modulating signal.

2. Frequency synthesizers are variable frequency generators using a phase lock loop that provide the frequency stability of a crystal oscillator and the convenience of incremental tuning over a broad frequency range.

3. Semi-duplex communication is referred to two-way communication where one party has to listen while the other is speaking.

4. Receivers are made up of collection of components and circuits such as local oscillators, amplifiers, modulators and other circuits.

5. Internal Noise gets into a Communication System through the medium.

6. "Handover" is the term used when a call is transferred from one zone to another zone due to the subscriber mobility in cellular communication.

7. Polar orbit satellites are about 36,000Km from the surface of the earth.

8. Modulation and multiplexing are electronic techniques for transmitting information efficiently from one place to another.

9. . "Frequency reuse" is based on the fact that after a distance a radio wave gets attenuated and the signal falls below a point where it can no longer be used or cause any interference.

10. A Yagi antennas is made up of one driven element and two or more parasitic elements.

Section B **SHORT ANSWERS** **(2 marks each)** **[30 marks total]**

No	Question	Answer
1.	What is the Frequency range of the "HF Band" in the frequency spectrum	
2.	What is the advantage of Polar orbiting satellite over Synchronous Orbiting?	
3.	Why do we need multiplexing in Communication?	
4.	Explain what forms at the output of a modulator circuit when two frequencies combine?	
5.	Define the term "Bandwidth" with regards to signal in the frequency spectrum?	
6.	Determine the modulating index (m) of an FM signal when a modulating signal of 15KHz deviates the carrier by 75KHz?	
7.	Explain how a simplex communication system works?	
8.	What does the "Nyquist rate of Sampling" mean to you?	
9.	Explain the term "wavelength" of a signal in the frequency spectrum?	
10.	Explain the reason why the "Super-heterodyne Receiver" is superior to other types like the TRF?	
11.	What do the terms "sensitivity and selectivity" relate to and mean in a communication system.	
12.	Calculate the effective length of an antenna for best transmission at 3GHz signal? (Velocity of light is 3×10^8 m/s)	
13.	Why is "Noise" so important to a Telecommunication Engineer?	
14.	List four major applications of satellite system?	
15.	A cluster is a group of adjacent cells in a Cellular Network. List two properties of a cluster.	

SECTION C **(Compulsory)**

(TOTAL: 30 marks)

Q1. A Communication receiver consists of various components and circuits and one of its primary roles is to have the sensitivity and selectivity to fully reproduce the modulating signal at its output.

a) Draw a block diagram of a typical Super-heterodyne receiver and label all components; and

b) Discuss the operation of the super-heterodyne receiver and in particular the intermediate frequency (IF) stage and its requirement.

Block diagram & labeling – (4 marks)
Discussion - (4 marks)

c) Draw and label a block diagram of a Tuned Radio Frequency (TRF) receiver; and

d) Discuss the reasons TRF receivers are not suitable for commercial use as compared to super-heterodyne receiver

Block diagram & labeling – (3 marks)
Discussion - (4 marks)

Q2.

a) In your own words explain the meaning of "Noise" and the reason why noise is important to a telecommunication Engineer. (2 marks)

b) Discuss the 3 main causes of external noise that a telecom engineer should be mindful of and how he or she can get the signal despite the existence of noise. (6 marks)

c) A receiver with a 75ohms input resistance operates at a temperature of 31°C. The receiver signal is at 86MHz with a bandwidth of 3MHz. The received signal voltage of 7.5μV is applied to an amplifier with a noise figure of 2.5dB.

Find the following:

i) The input noise power; (2 marks)

ii) The input signal power; (1 marks)
iii) S/N in dB; (1 marks)
iv) The noise factor & S/N of the amplifier; (2 marks)
v) The noise temperature of the amplifier. (1 marks)

(7 marks)

Section D **(Select 2 from the 3 Questions)**

Question 1

[TOTAL: 30 marks]

a) A 5.0 MHz RF carrier signal is modulated with a 10 KHz sine wave signal. The modulated carrier voltage is 25 V maximum and 5V minimum across 50 ohms resistive load impedance.
Determine the following:

i) The RF Carrier voltage without modulation;
ii) The modulation index;
iii) The Carrier power;
iv) The sideband power;
v) Total power;
vi) Sideband frequencies;
vii) Bandwidth

(7 marks)

b). A 25 KHz modulating signal in an FM broadcast channel was deviated to 150 KHz.

Determine the maximum bandwidth using:

i) The Bessel Function table (see attached)
ii) Carson's rule. **[8 marks]**

Question2.

a).

i) Draw and label a block diagram of a satellite transponder and briefly explain its operation. **[3 marks]**

ii) Determine the uplink frequency if the downlink transmitter is 4050MHz. Assume Local Oscillator frequency of 2.5GHz. **[3 marks]**

iii) If one of the transponders is used for binary transmission, determine the maximum theoretical data rate it can handle. (Bandwidth of one transponder channel is 36MHz) **[2 marks]**

b).

i) List the 2 advantages of cellular radio to mobile radio telephone services.
ii) Explain the term "Call Handoff" as used in cellular communication?

[7 marks]

Question 3.

a) The greatest use of multiplexing in our everyday lives is in the use of telecommunication system where millions of calls are multiplexed on cables, long distance fiber optic and satellite to name a few;

i) Explain the term "Pulse Code Modulation" (PCM) and the reasons it is used widely in telecommunication systems? (3 marks)

ii) TDM (Time Division Multiplexing) can be configured to support E1. From voice frequency (0 – 4 KHz), explain how an E1 can be derived? (5 marks)

iii) You are the Planning Engineer for TFL. If say, after a survey, a maximum of 500 circuits is required for the LABASA – SUVA route to ensure no congestion in the telephone switch, how many E1s will you install? [3 marks]

b). Explain the reason why only one sideband is normally transmitted in AM transmission. Explain the four major benefits of SSB. [4 marks]

----------**The End**----------

Bessel Function Table

Modulation Index	Carrier	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	14th	15th	16th
0.00	1.00															
0.25	0.98	0.12														
0.5	0.94	0.24	0.03													
1.0	0.77	0.44	0.11	0.02												
1.5	0.51	0.56	0.23	0.06	0.01											
2.0	0.22	0.58	0.35	0.13	0.03											
2.5	-0.05	0.50	0.45	0.22	0.07	0.02										
3.0	-0.26	0.34	0.49	0.31	0.13	0.04	0.01									
4.0	-0.40	-0.07	0.36	0.43	0.28	0.13	0.05	0.02								
5.0	-0.18	-0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02							
6.0	0.15	-0.28	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02						
7.0	0.30	0.00	-0.30	-0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02					
8.0	0.17	0.23	-0.11	-0.29	-0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03				
9.0	-0.09	0.24	0.14	-0.18	-0.27	-0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03			
10.0	-0.25	0.04	0.25	0.06	-0.22	-0.23	-0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.01		
12.0	-0.05	-0.22	-0.08	0.20	0.18	-0.07	-0.24	-0.17	0.05	0.23	0.30	0.27	0.20	0.07	0.03	0.01
15.0	-0.01	0.21	0.04	0.19	-0.12	0.13	0.21	0.03	-0.17	-0.22	-0.09	0.10	0.24	0.25	0.18	0.12

Fig 1

Formulae you can use

$V_n = \sqrt{4KTBR}$

Boltsman Constant: 1.38×10^{-23}

$S/N = \frac{P_s}{P_n}$; Carrier Power; $P_c = V^2/R$;

NF = 10 log NR

$NR = \frac{S/N_{input}}{S/N_{output}}$

$T_N = 290(NR - 1)$

$$Vc = \frac{V_{max} + V_{min}}{2}$$

$$\text{Modulation index} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} \times 100\%$$

dB = 10log P (where P = Pout/Pin)

Speed of light $V = f\lambda$ where $V = 3 \times 10^8$

$$\text{Sideband Power; } P_{sb} = \frac{m^2 P_c}{2}$$

$m_f = \frac{f_d}{f_m}$ Bandwidth = $2f_m N$;

Bandwidth Carson $2(f_{d(max)} + f_{m(max)})$