FIJI NATIONAL UNIVERSITY
College of Engineering, Science & Technology

DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE553 – ELECTRONIC COMMUNICATIONS SYSTEM.

FINAL EXAMINATION – TRIMESTER 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 amplitude 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. Yagi antennas are made up of one driven element and a parasitic element.

4. Most electronic communication is two-way and is referred to as simplex.

5. In a cellular telephone system, each Base station is connected by telephone lines or microwave radio relay link to a master control center known as the Mobile telephone switching office.

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

7. "Noise" is a problem in a Communication System whenever the received signal levels are very low in amplitude.

8. According to the Nyquist theorem, the sampling rate must be at least 2 times the highest frequency contained in the signal.

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

10. PCM is a process of changing digital signals to analog signals.

Section B SHORT ANSWERS [2 marks each] **[30 marks]**

No	Question	Answer
1.	What is the Frequency range of the "VHF Band" in the frequency spectrum	
2.	What is the main difference between an analog signal and a digital signal and give examples?	
3.	Why do we need modulation in Communication?	
4.	What happens when the signal frequency (fm) (intelligence) combines with the Carrier (fc) in AM?	
5.	What does the term "Bandwidth" means with regards to signal in the frequency spectrum?	
6.	Determine the modulating index (m) of an AM signal when V_m is 8V and V_c is 10V? Comment on quality of the signal?	
7.	Explain how a half-duplex communication system operates?	
8.	What is the sampling rate (frequency) of a PCM system with frequency signal band of 3.0 – 10.5 KHz.	
9.	Explain the term "wavelength" of a signal in the frequency spectrum?	
10.	What is the fundamental difference between Time Division Multiplexing (TDM) to Frequency Division Multiplexing (FDM)?	
11.	Define the terms "sensitivity and selectivity" in relation to communication.	
12.	Calculate the effective length of an antenna for best transmission at 30MHz signal? (Velocity of light is 3×10^8 m/s)	
13.	Explain the term "Multiplexing" as used in a Communication systems and explain the benefit?	
14.	List two major applications of satellite system?	
15.	What will be the modulation index of a Frequency Modulated wave if a modulating signal of 5KHz deviates the carrier by 100KHz	

SECTION C **(Compulsory)** **[TOTAL: 30 marks]**

Q1a) Whenever a Carrier signal is Amplitude Modulated by an information signal (modulating signal), new signals at different frequencies are generated as part of the process.

i) Draw the "frequency display" of the new signals generated and discuss the power distribution. **(4 marks)**

ii) Explain how you can obtain a Single Side Band (SSB) from the modulated signals? **(4 marks)**

iii) List down the 4 benefits of a SSB signal **(4 marks)**

b) An AM broadcasting transmitter has a Carrier power of 1.5KWatts. The percentage modulation is 80%. Calculate the following:

i) The total power of the transmitter **(4 marks)**

ii) The Power in one sideband. **(4 marks)**

Q2. 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) Thirty (30) voice channels plus two (2) control channels can be multiplexed (Time Division Multiplexing) to support an E1 signal. From voice frequency (0.3 – 4 KHz), explain how an E1 signal can be derived? **(4 marks)**

ii) You are the Planning Engineer for TFL. If say, after a survey, a maximum of 320 circuits is required for the LABASA – SUVA route to ensure no congestion in the telephone switch during the peak hours, how many E1s will you install? **(2 marks)**

iii) Discuss and illustrate through a diagram the European Plesiochronous Digital Hierarchy (European PDH hierarchy). **(4 marks)**

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

[TOTAL: 30 marks]

Question1.

a) Pre-emphasis and de-emphasis circuits are commonly used in FM broadcasting transmission and digital audio recording.

i) Draw a pre-emphasis and a de-emphasis circuit and their frequency response **(4 marks)**

ii) Explain the reason why and where emphasis circuits are employed in FM **(2 marks)**

iii) Draw a combined frequency response of Pre-emphasis and De-emphasis noting the "time constant" and "cut-off frequency". **(2 marks)**

b) A 15 KHz modulating signal in an FM broadcast channel was deviated to a maximum of 150 KHz.

Determine the maximum bandwidth using:

i) The Bessel Function table (see attached)
ii) Carson's rule. **(7 marks)**

Question2.

a) A 1.0 MHz RF carrier signal is modulated with a 25 KHz sine wave signal. The modulated carrier voltage is 25 V maximum and 10V minimum across 50 ohms resistive load impedance.

Determine the following:

i) The RF Carrier voltage;
ii) The modulation index;
iii) The Carrier power;
iv) The sideband power;
v) Total power;
vi) Sideband frequencies;
vii) Bandwidth **(7 marks)**

b) An antenna acts as interface between a Transmitter or Receiver and free space.

i) Calculate the effective length of a half-wave dipole antenna if the operating frequency is 107.3 MHz? **(2 marks)**

ii) What is the difference between an omnidirectional antenna to a directional antenna and give examples. **(3 marks)**

iii) Draw a "Yagi array" antenna and mark all the elements associated with it **(3 marks)**

Question 3

a) 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.

i) Draw a block diagram of a typical super-heterodyne receiver and label all the blocks. **(3 marks)**

ii) What is the basic difference of a super-heterodyne receiver as compared to a TRF receiver? **(3 marks)**

iii) Draw the block diagram of a transmitter module, label them and discuss their functions. **(5 marks)**

iv) List down and discuss the four (4) basic function of a transmitter **(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 = $2f_m N$; $2(f_{d(\max)} + f_{m(\max)})$