PROGRAM	:	B TECH *ELECTRICAL ENGINEERING*
SUBJECT	:	**RADIO ENGINEERING IV**
CODE	:	**EER411**
DATE	:	MAIN EXAMINATION 25 MAY 2019
DURATION	:	12:30 - 15:30
WEIGHT	:	40 : 60
FULL MARKS	:	100
TOTAL MARKS	:	100

EXAMINERS	:	PROF THOKOZANI C SHONGWE
MODERATOR	:	DR EBENEZER ESENOGHO
NUMBER OF PAGES	:	4 PAGES, INCLUDING 1 PAGE OF FORMULAS

INSTRUCTIONS	:	CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT)
	:	USE ONLY THE ANSWER SHEET PROVIDED WITH THIS PAPER

INSTRUCTIONS TO CANDIDATES:

1. 100 MARKS = 100%

2. ATTEMPT ALL QUESTIONS.

3. THEORY TYPE QUESTIONS MUST BE ANSWERED IN POINT FORM BY CAREFULLY CONSIDERING THE MARK ALLOCATION.

4. QUESTIONS MAY BE ANSWERED IN ANY ORDER, BUT ALL PARTS OF QUESTION MUST BE KEPT TOGETHER.

5. ALL DIAGRAMS AND SKETCHES MUST BE DRAWN NEATLY AND IN PROPORTION.

6. ALL DIAGRAMS AND SKETCHES MUST BE LABELLED CLEARLY.

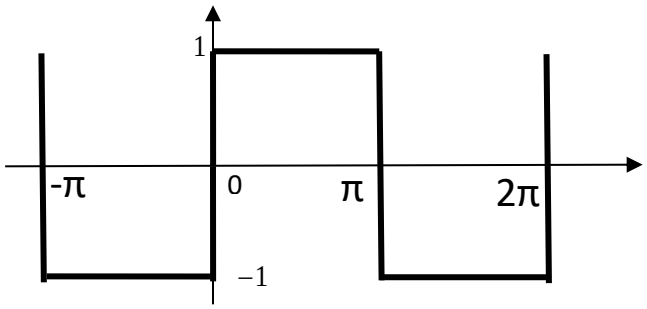
7. ALL WORK DONE IN PENCIL EXCEPT DIAGRAMS AND SKETCHES WILL BE CONSIDERED AS ROUGH WORK.

8. NOTE: MARKS WILL BE DEDUCTED FOR WORK WHICH IS POORLY PRESENTED.

9. NEGATIVE MARKING APPLIES IF YOUR ANSWER DOES NOT COMPLY WITH THE DETAIL REQUIRED AS REQUESTED IN CERTAIN QUESTIONS.

Question 1

Given the signal below,



calculate the:

(1) Fourier coefficients and hence give the Fourier series the signal.
(2) Exponential Fourier coefficients of the signal.

(30+20)

Question 2

(a) Determine the Nyquist rate of the following signal,

$x(t) = 3 \cos(50\pi t + 3) + 2 \cos(100\pi t) - \cos(300\pi t + \pi/2)$.

(b) For a Telephone spectrum [*300 Hz, 3400 Hz*]:
1. Identify the minimum sampling frequency.
2. If $L = 256$ levels are used in the quantization
    a. Calculate the transmission rate R in bits per second.
    b. Calculate the minimum PCM bandwidth.

(c) A signal *m(t)* of bandwidth $B = 4$ *kHz* is transmitted using a binary companded PCM with $\mu = 100$. Compare the case of $L = 64$ with the case of $L = 256$ from the point of view of transmission bandwidth and the output SNR.

(d) A binary channel with bit rate Rb=36000 bits/s is available for PCM transmission. Find appropriate values of the sampling rate fs, the quantizing level - *L*, and the binary digits *n*, assuming the signal bandwidth is $B = 3.2$ *kHz*.

(3+6+6+7)

Question 3

a) Define the following terms in the context of antenna design and construction.
i. Polarization
ii. Isotropic
iii. Power radiation pattern
iv. lobes
v. Directivity
vi. Beamwidth

b) Sketch and explain the construction of a log-periodic dipole array antenna.

c) Estimate the power gain and beamwidth for NASA's 200 ft parabolic antenna used in the deep space network for tracking spacecraft at planetary distance. Use 8.4 GHz (X-band) frequency.

(12+10+6)

TOTAL MARKS : 100

ANNEXURE

A. If the function x is assumed to be continuous over the range [-π, π], that is, period T= 2π, then we have

$$a_0 = \frac{1}{2\pi}\int_{-\pi}^{\pi} x(t)dt \qquad = \frac{1}{\pi}\int_{0}^{\pi} x(t)dt$$

$$a_k = \frac{1}{\pi}\int_{-\pi}^{\pi} x(t)\cos ktdt \qquad = \frac{2}{\pi}\int_{0}^{\pi} x(t)\cos ktdt$$

$$b_k = \frac{1}{\pi}\int_{-\pi}^{\pi} x(t)\sin ktdt \qquad = \frac{2}{\pi}\int_{0}^{\pi} x(t)\sin ktdt$$

B. EULER'S FORMULA

$$e^{\pm j\alpha} = \cos(\alpha) \pm j\sin(\alpha)$$

$$\cos(\alpha) = \frac{1}{2}\left(e^{j\alpha} + e^{-j\alpha}\right), \quad \sin(\alpha) = \frac{1}{2j}\left(e^{j\alpha} - e^{-j\alpha}\right)$$

where $\alpha = k\omega_o t$ in the signal Fourier series expansion formula