PROGRAM	:	B TECH *ELECTRICAL ENGINEERING*
SUBJECT	:	**RADIO ENGINEERING IV**
CODE	:	**EER411**
DATE	:	JUNE EXAMINATION 31 MAY 2018
DURATION	:	08:30 - 11:30
WEIGHT	:	40 : 60
FULL MARKS	:	100
TOTAL MARKS	:	100

EXAMINERS	:	DR THOKOZANI C SHONGWE
MODERATOR	:	MR PATRICK NKWARI KIBAMBE
NUMBER OF PAGES	:	5 PAGES, INCLUDING 1 PAGE OF FORMULAS

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

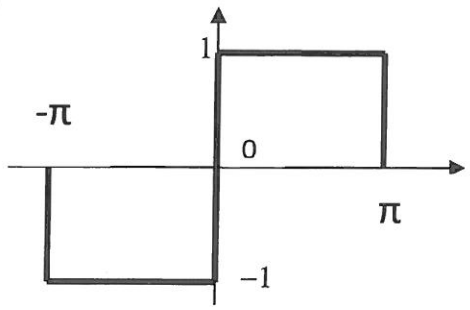
INSTRUCTIONS TO CANDIDATES:

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.

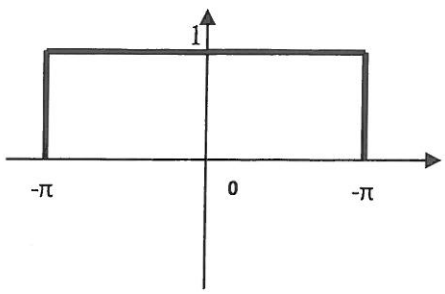
Question 1

Given the signal in (a) and (b) below,

(a)



(b)



calculate the:

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

(2) Exponential Fourier coefficients of each signal.

(30+20)

Question 2

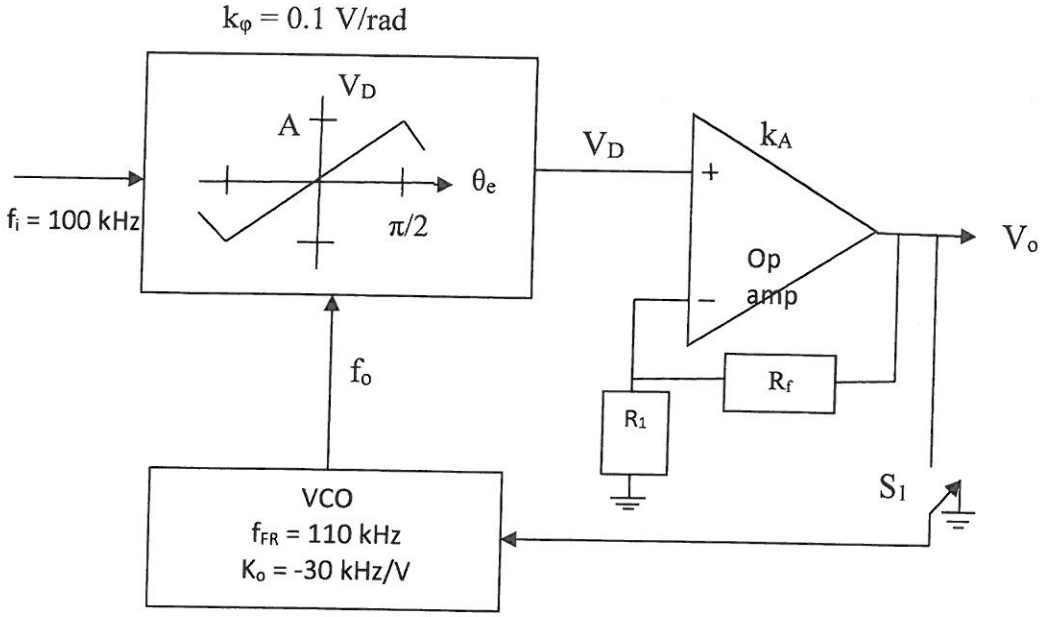
a) Give a sketch of a phase-locked loop block diagram, clearly showing the following components: Phase detector, loop filter, amplifier and voltage controlled oscillator.

b) Explain the basic PLL behaviour under the headings: 1. Locking the loop, 2. Acquisition, 3. Locked Loop: tracking mode and 4. Hold in range.

(5+8)

Question 3

The figure below provides enough information to analyse the static behaviour of a phase-locked loop. $R_f = 4\ k\Omega$ and $R_1 = 1\ k\Omega$.



Using the information provided in the figure:

a) Determine K_A for the op-amp.

b) Calculate the loop gain in units of s^{-1} and in decibels (at $\omega = 1$ rad/s).

c) With S_1 open as shown, what is observed at V_o with an oscilloscope?

d) When the loop is closed and the phase locked, determine

(i) The VCO output frequency
(ii) The static phase error at the phase comparator output.
(iii) V_o. (is this rms, pk-pk or what?)

e) Determine the hold-in range Δf_H.

f) Determine A, the maximum value of V_D.

(2+2+2+7+2+2)

Question 4

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

b) An X-band (10 GHz) dish antenna must have a 1^0 beam width.

(i) What must be the diameter of the parabolic dish?
(ii) If 55% efficient, what will be the antenna gain?

(10+10)

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