

2207/302
TELECOMMUNICATION PRINCIPLES
June/July 2018
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS)
(COMMUNICATION AND NAVIGATION OPTION)**

TELECOMMUNICATION PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Mathematical tables/Non-programmable scientific calculator;

Graph paper;

Drawing instruments.

Answer FIVE of the EIGHT questions in the answer booklet provided.

All questions carry equal marks.

Maximum marks for each part of a question are as indicated.

Candidates should answer the questions in English.

This paper consists of 6 printed pages.

**Candidates should check the question paper to ascertain that
all the pages are printed as indicated and that no questions are missing.**

1.

(a) Figure 1 shows a circuit diagram of an emitter follower amplifier.

- (i) Draw the h-parameter equivalent circuit ignoring h_{oe} and h_{re} .
- (ii) From the equivalent circuit in a(i) determine the input impedance of the amplifier if the transistor has $h_{ie} = 1\text{ k}\Omega$ and $h_{fe} = 50$.

(8 marks)

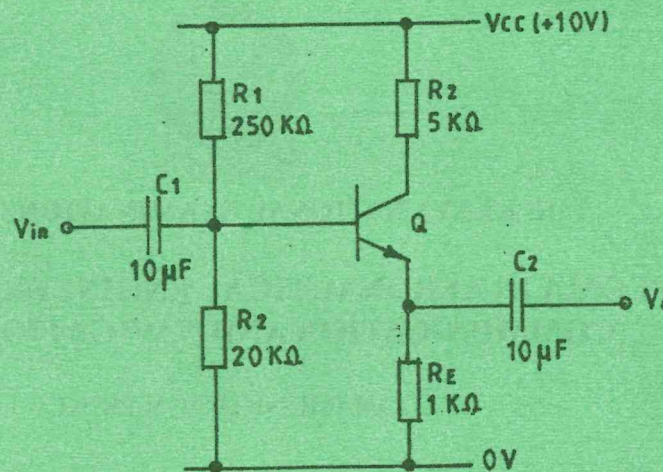


Fig. 1

(b) A transistor used in a single-ended transformer-coupled class A power amplifier has the data given in table 1. The load resistor = $5\ \Omega$, transformer turns ratio = 3.464:1, supply voltage = 20V and the quiescent base bias current = 10 mA.

- (i) plot the characteristic curves.
- (ii) construct the a.c loadline.
- (iii) use the loadline in (ii) to determine the:

- (I) a.c power output;
- (II) d.c power input
- (III) efficiency.

(12 marks)

Table 1

Vce (V)	Ic (A)				
	I _b = 2 mA	I _b = 6 mA	I _b = 10 mA	I _b = 14 mA	I _b = 18 mA
1	0.02	0.20	0.40	0.60	0.80
40	0.20	0.40	0.60	0.80	1.00

2. (a) (i) State **two** ways of improving the frequency stability of sinusoidal oscillators.
- (ii) With the aid of an electrical equivalent circuit diagram, explain how resonance occurs in a piezoelectric crystal and sketch its response curve. (10 marks)

- (b) An amplifier has a gain of 50 dB. A fraction $\frac{1}{50}$ of the output voltage is fed back as negative feedback.
- (i) Determine the:
- (I) change in gain in dB;
- (II) reduction in harmonic distortion.
- (ii) Sketch, on the same axis, the response curves of the amplifier without feedback and with feedback. (10 marks)

3. (a) (i) Define the following with respect to tuned circuits:
- (I) selectivity;
- (II) Q-factor.
- (ii) Sketch the curve of current against frequency in a series resonant circuit and explain its shape. (7 marks)

- (b) With the aid of a circuit diagram, explain how high frequency compensation is achieved in wideband amplifiers. (5 marks)

- (c) A parallel-resonant circuit consists of 20 pF capacitor in parallel with a 50 μ H inductor of resistance 10 Ω . Determine the:
- (i) resonant frequency;
- (ii) dynamic impedance;
- (iii) Q-factor;
- (iv) bandwidth. (8 marks)

4. (a) (i) State **three** applications of unijunction transistors.
- (ii) Describe the operation of a varactor diode and sketch its characteristic curve. (8 marks)

- (b) Figure 2(a) and 2(b) shows circuit diagrams of diode clippers. Sketch the output waveform for each clipper assuming a sinusoidal input whose peak value is greater than V_1 and V_2 . (4 marks)

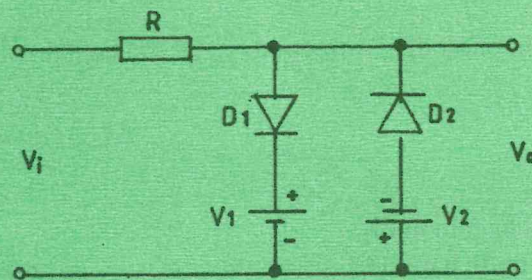


Fig. 2 (a)

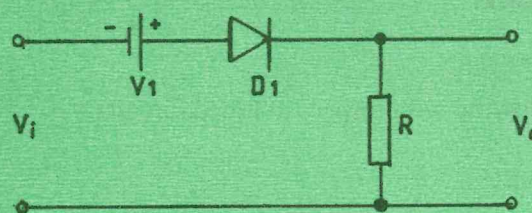


Fig. 2 (b)

- (c) The output of a linear variable differential transformer (LVDT) is connected to a 5 V voltmeter through an amplifier whose amplification factor is 250. An output of 2 mV appears across the terminals of the LVDT when the core moves through a distance of 0.5 mm. The voltmeter scale has 100 divisions and the scale can be read to $\frac{1}{5}$ of a division. For the set up, determine the:

- (i) sensitivity;
- (ii) resolution. (8 marks)

5. (a) (i) Define amplitude modulation (AM).
 (ii) With the aid of a circuit diagram, describe the operation of a Cowan modulator. (7 marks)

- (b) Figure 3 shows a block diagram of the phase-shift method of generating single sideband (SSB) signal. Obtain the expression for the output voltage, V_o . (6 marks)

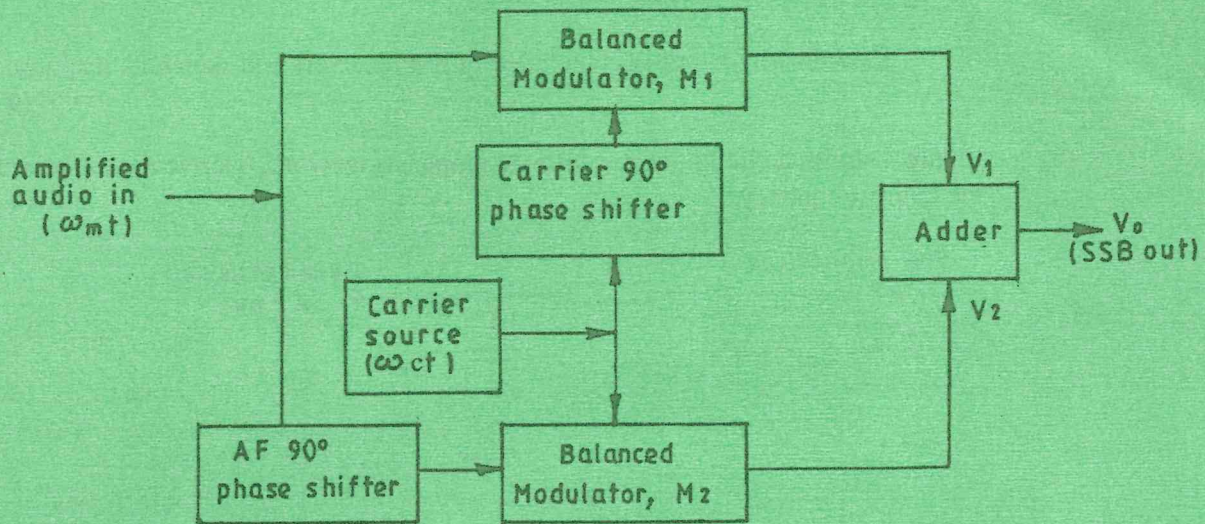


Fig. 3

- (c) An AM signal has a carrier power of 2 mW and each side frequency is $\frac{1}{5}$ the carrier voltage. Determine the:

- (i) modulation index;
- (ii) total power;
- (iii) side frequency.

(7 marks)

6. (a) (i) State **two** losses that occur in transmission lines.

- (ii) Draw the equivalent electrical circuit diagram for each of the following transmission lines:

(I) short circuited $\frac{\lambda}{4}$ lines;

(II) open circuited $\frac{\lambda}{4}$ lines.

(6 marks)

- (b) With the aid of a labelled diagram, describe double-stub matching as used in transmission.

(5 marks)

- (c) The sending end of an open wire line is connected to a generator having an open circuit e.m.f of 10 V at a frequency of 1 kHz. If the line primary constants are $R = 8 \Omega$, $L = 3\text{mH}$, $C = 7500 \text{pF}$ and $G = 0.25 \mu\text{S}$, determine the:

- (i) characteristic impedance; $Z_0 = \frac{1}{\rho}$
- (ii) sending-end current;
- (iii) propagation coefficient;
- (iv) phase shift coefficient.

(9 marks)

7. (a) (i) State **three** advantages of frequency modulation (FM) over amplitude modulation (AM) systems.
- (ii) Explain why a limiter is included in FM receivers and sketch its response curve. (9 marks)
- (b) Figure 4 shows a circuit diagram of a de-emphasis network. Derive the expression for the cutoff frequency. (4 marks)

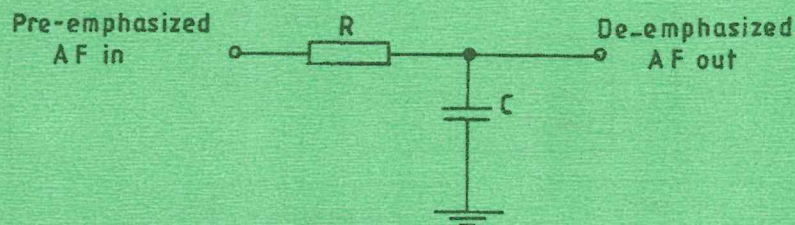


Fig. 4

- (c) A 10 V, 65 MHz carrier is frequency modulated by a 200 Hz audio sine wave and the maximum deviation is 10 kHz.
- (i) Determine the:
- (I) angular frequency of the carrier;
 - (II) angular frequency of the modulating signal;
 - (III) modulation index.
- (ii) Write down the expression for the instantaneous voltage of the modulated wave. (7 marks)
8. (a) (i) With the aid of a labelled diagram, describe selective fading of sky waves.
- (ii) State **two** methods of minimizing the fading in a(i). (8 marks)
- (b) A p.c.m system uses 128 quantization levels with each sample signalled to the line accompanied by one synchronization bit. If the bandwidth required for transmission is 32 kHz, determine the:
- (i) bit rate;
 - (ii) sampling frequency. (6 marks)
- (c) An ionospheric layer has a maximum electron density of 5×10^{11} electrons/m³. If the angle of incidence is 40° and angle of refraction is 60°, determine the:
- (i) critical frequency;
 - (ii) maximum usable frequency;
 - (iii) refractive index of the layer. (6 marks)

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