THE KENYA POLYTECHNIC

ELECTRICAL/ELECTRONICS ENGINEERING

DEPARTMENT

HIGHER DIPLOMA IN ELECTRICAL ENGINEERING

END OF YEAR II EXAMINATIONS

NOVEMBER 2006

COMMUNICATION SYSTEMS

3 HOURS

INSTRUCTIONS TO CANDIDATES:

You should have the following for this examination:

Answer booklet

Calculator/Mathematical tables

Answer any FIVE of the following EIGHT questions.

All questions carry equal marks and the maximum marks for each part of a question are as shown.

This paper consists of 4 printed pages.

1. (a) With the aid of a block diagram, describe the operation of an independent sideband transmitter. (6 marks)

   (b) (i) Draw a circuit diagram of a varactor diode modulator and describe its operation.

   (ii) An oscillator operating at 200MHz has a 75pF capacitor in its timing circuit. Determine, from first principles the total capacitance swing the varactor must supply to have a 100KHz peak deviation. (14 marks)

2. (a) Explain the following with respect to radio wave propagation:

   (i) Tropospheric scatter (ii) Ducting (10 marks)

   (b) Describe TWO effects of the earth's curvature on radio wave propagation. (2 marks)

   (c) (i) Derive an expression for the maximum distance of line of sight transmission for a radio system in terms of the heights of the transmitting and receiving aerials. Assume the radius of the earth to be 6370km.

   (ii) The transmitting and receiving aerials are each 100m high. Determine the line of sight distance. (8 marks)

3. (a) With the aid of a diagram, describe the following with respect to aerials:

   (i) Broadside array (ii) End fire array (8 marks)

   (b) (i) Describe with the aid of a diagram the parabolic reflector.

   (ii) A parabolic reflector operating at 10GHz has a diameter of 6m and an illumination efficiency of 0.65. Determine is directivity, beam width and effective area. (12 marks)

4. (a) Explain the following multiple access methods with respect to satellites:

   (i) FDMA (ii) TDMA (6 marks)

   (b) Derive an expression for the velocity of satellite in orbit in terms of its mass, earth's radius and height above ground. (6 marks)

(c) Calculate the carrier to noise power (C/No) in decibels at an earth receiving station, from a satellite transmitting an effective isotropic radiated power (EITRP) of 49.5dBW at a frequency of 12GHz. The earth station antenna angle of elevation is 1570C and the receiving figure of merit is 40.7dBs. (8 marks)

5. (a) Describe the following with respect to noise:

(i) Noise factor (ii) Noise temperature (4 marks)

(b) With the aid of a block diagram describe how the noise factor of an active network may be measured. (5 marks)

(c) (i) Two amplifying stages are connected as shown in figure 1.

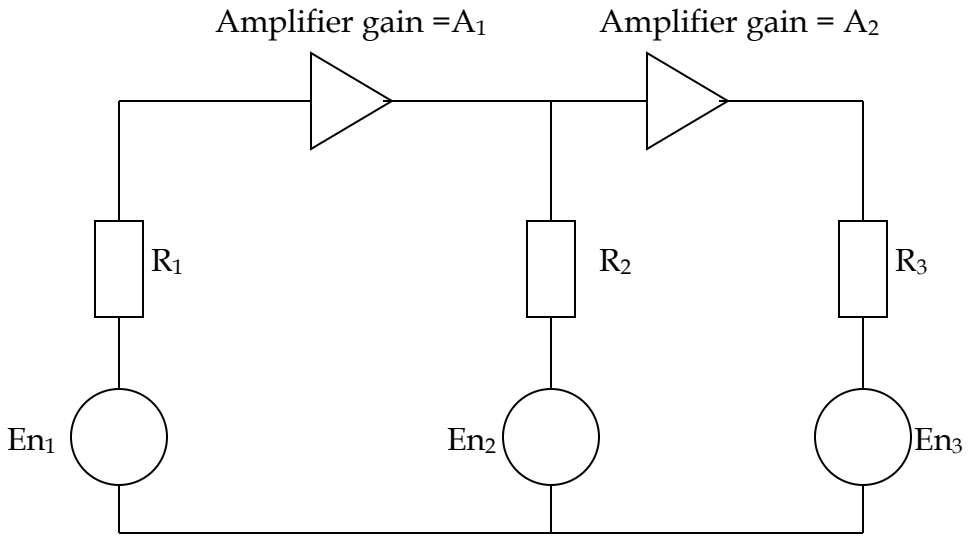

Figure 1

Derive an expression for the total equivalent noise resistance at the input of the first stage.

(ii) The first stage of a two-stage amplifier has a voltage gain of 10, a 600Ω input resistor, a 1, 600Ω equivalent noise and a 27kΩ output resistor. For the second stage these values are 25, 81kΩ, 10kΩ and 1MΩ respectively. Calculate the equivalent input noise resistance of this two-stage amplifier. (11 marks)

6. (a) With the aid of a circuit diagram, describe the operation of an anode modulated class C amplifier. (8 marks)

(b) The modulator in (a) has an audio frequency sine wave of 3kV peak value developed across the secondary of the modulating transformer. The stage has an anode efficiency of 75% and delivers 1.5kW of power into the load. Calculate:

(i) The depth of modulation.

(ii) The mean anode current.

(iii) The power supplied by the modulator.

(iv) The total r.f power delivered to the load circuit.

State the assumptions made. (12 marks)

7. (a) Define the following with respect to telephony:

(i) Full availability (ii) Busy hour

(iii) Grade of service (3 marks)

(b) With the aid of a block diagram, describe how a digital computer may be used for a message switching telephone system. (12 marks)

(c) A full availability group of 4 switches has 2 earlengs of traffic offered to it. Calculate the grade of service. State and define all formulae used. (5 marks)

8. (a) Define the following with respect to waveguides:

(i) Cut-off wavelength (ii) Dormant mode (2 marks)

(b) A rectangular waveguide measures 3x4.5cm internally. A signal of 9GHz is propagated in it. Calculate, for a TE_{10} mode;

(i) The cut-off wavelength

(ii) The guide wavelength

(iii) The group and phase velocities

(iv) The characteristic wave impedance (7 marks)

(c) With the aid of diagram(s) describe the construction and operation of a PIN diode, naming a practical application. (11 marks)