2507/206
COMMUNICATION AND
TELECOMMUNICATION SYSTEMS
Oct./Nov. 2017
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS OPTION)

MODULE II

COMMUNICATION AND TELECOMMUNICATION SYSTEMS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Scientific calculator.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing any **THREE** questions from section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.
Take: ***Electronic charge*** $e = 1.602 \times 10^{-19} C$
Permittivity of free space $\epsilon = 8.854 \times 10^{-12}$ F/M
Permeability of free space $\mu = 4\pi \times 10^{-7}$ H/M
Velocity of light $C = 3.0 \times 10^{8}$ m/s
Free space wave impedance $Z_0 = 377\ \Omega$

This paper consists of 5 printed pages.

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

SECTION A: COMMUNICATION SYSTEMS

*Answer any **THREE** questions from this section.*

1. (a) With the aid of a block diagram, describe the operation of a high level AM radio transmitter. (8 marks)

(b) A varactor diode frequency modulator has a capacitance of 50 pF while the tuning circuit capacitance is 200 pF. The transmission frequency is 90 MHz. Determine the:

(i) value of the tuned circuit inductance;

(ii) necessary change in the diode capacitance for transmission frequency of 96 MHz. (6 marks)

(c) List **three** areas of application of varactor diodes. (3 marks)

(d) State **three** requirements of transmitters. (3 marks)

2. (a) Define the following with respect to radar systems:

(i) duty ratio;
(ii) pulse repetition frequency;
(iii) peak power. (3 marks)

(b) Derive the radar range equation. (9 marks)

(c) A double sideband (DSB) AM system radiates 200 kW when the depth of modulation is 75%. Determine the:

(i) carrier power;

(ii) power of sidebands;

(iii) transmission efficiency. (8 marks)

3. (a) Define the following as used in television systems:

(i) aspect ratio;

(ii) synchronization. (2 marks)

(b) With the aid of a labelled diagram, explain interleaving as applied to colour TV signal transmission. (7 marks)

(c) A PAL TV standard consists of 625 lines per frame and 25 frames per second. Determine the:

(i) line scan frequency;

(ii) field scan period;

(iii) time taken to scan one line. (7 marks)

(d) Highlight **four** challenges facing migration from analogue to digital TV transmission. (4 marks)

4. (a) Define the following with respect to satellite communications:

(i) station keeping;

(ii) angle of inclination;

(iii) geosynchronous orbit. (3 marks)

(b) List **three** classes of satellites and their corresponding frequency ranges. (6 marks)

(c) An 11 GHz satellite station, located 36,000 km above the earth surface radiates 5 W using an antenna of 22 dB power gain. The receiving antenna has an effective aperture of 12 m^2 and a power gain of 55 dB. Determine the:

(i) power flux density at the receiving point;

(ii) received power;

(iii) transmission pathloss in dB. (9 marks)

(d) Describe link budget with respect to satellite systems. (2 marks)

5. (a) Describe the 2G mobile technology. (3 marks)

(b) (i) State **three** merits of modulation. (3 marks)

(ii) Show that output power of a double AM signal is:

$$Pout = P_c\left[1 + \frac{m^2}{2}\right]$$

(6 marks)

(c) With the aid of a block diagram, describe the filter method of single sideband transmitter. (8 marks)

SECTION B: TELECOMMUNICATION PRINCIPLES

*Answer any **TWO** questions from this section.*

6. (a) Define the following with respect to wave propagation:

(i) virtual height;

(ii) critical frequency;

(iii) maximum usable frequency. (3 marks)

(b) Describe the following ionospheric layers:

(i) D - layer;

(ii) E - layer. (6 marks)

(c) A coaxial cable with a characteristic impedance of 75 Ω has a maximum voltage standing wave of 52 V and a maximum voltage of 17 V. Determine the:

(i) standing wave ratio (SWR);

(ii) reflection coefficient;

(iii) value of resistive load. (6 marks)

(d) With the aid of a diagram, explain double stub matching technique. (5 marks)

7. (a) Define the following as used in waveguides:

(i) cut-off frequency;

(ii) group velocity. (2 marks)

(b) A rectangular waveguide measures 3 cm x 4.5 cm internally and has 9 GHz signal propagated in it. Determine the:

(i) cut-off wavelength;

(ii) guide wavelength;

(iii) phase velocity. (8 marks)

(c) With the aid of a diagram, explain the operation of a Travelling Wave Tube (TWT). (7 marks)

(d) State **three** advantages of fibers optic cables over coaxial cables. (3 marks)

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

(i) directivity;

(ii) polarization;

(iii) effective isotropic radiated power (EIRP). (3 marks)

(b) With the aid of a diagram, explain the operation of a log periodic array antenna. (8 marks)

(c) A three stage amplifier operates over a bandwidth of 10 kHz at a temperature of 300 degrees kelvin. The three stages have respectively:

(i) voltage gain of 20, 25 and 25;

(ii) input resistor of 600 Ω , 40 kΩ and 80 kΩ;

(iii) equivalent noise resistance of 1500 Ω, 6 kΩ and 10 kΩ;

(iv) output resistor of 30 kΩ, 100 kΩ and 1MΩ.

Determine the:

(I) equivalent input noise resistance of the overall 3-stage amplifier;
(II) equivalent noise voltage of the first stage. (9 marks)

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