

2207/303

COMMUNICATION AND NAVIGATION SYSTEMS

Oct/Nov. 2006

Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

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

COMMUNICATION AND NAVIGATION SYSTEMS

**3 hours**

**INSTRUCTIONS TO CANDIDATES**

*You should have the following for this examination:*

*Answer booklet*

*Mathematical tables*

*Answer any **FIVE** of the following **EIGHT** questions.*

*All questions carry equal marks.*

**This paper consists of 4 printed pages**

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

1. (a) (i) List any TWO advantages of the Cassegrain feed method over the horn feed method in microwave antennas.
  - (ii) Draw a labelled diagram of a 4-element folded dipole Yagi antenna and describe its operation on receive mode. (9 marks)
  - (b) With the aid of a labelled diagram, describe how the voltage standing wave ratio (VSWR) of a feeder cable is measured. (5 marks)
  - (c) A 6-dipole end-fire array radiates 2kw at 45 MHz towards a dipole antenna 140 km away. If the path loss is 35dB, determine:
    - (i) the power flux density at the dipole.
    - (ii) the power received by the dipole. (6 marks)
2. (a) (i) State any THREE performance specifications of an earth satellite station.
  - (ii) Explain the following as applied to satellite antenna tracking:
    - I Program tracking.
    - II Step tracking. (9 marks)
  - (b) With the aid of a labelled block diagram, describe the operation of the communication sub-system of a space satellite. (6 marks)
  - (c) An earth satellite station, operating at 8GHz, radiates 5KW towards a space satellite 36,000 km away. If the transmitting antenna has a gain of 55dB, determine the gain of the receiving antenna needed to receive  $4.5 \mu\text{W}$ . (Take antenna efficiency to be 0.64). (5 marks)
3. (a) (i) State any TWO advantages of the synchronous detector over the diode AM detector.
  - (ii) With the aid of a labelled block diagram, describe the operation of a single sideband (SSB) radio receiver. (8 marks)
  - (b) Draw a circuit diagram of an FM transistor amplitude limiter and explain its operation. (6 marks)
  - (c) An FM broadcast receiver uses an antenna coupling circuit with a loaded Q-factor of 90 and an intermediate frequency (IF) of 10.7 MHz. Determine:
    - (i) the image frequency when the signal frequency is 25 MHz.
    - (ii) the image rejection ratio in dB. (6 marks)

4. (a) (i) List any TWO demerits of optic fibers compared to coaxial cables.
- (ii) With the aid of a labelled light profile diagram, explain the operation of the graded index optic fiber. (7 marks)
- (b) (i) Draw a labelled block diagram of an optic fiber communication system and describe its operation.
- (ii) With the aid of a labelled diagram, describe the operation of a Neon-Helium gas laser. (13 marks)
5. (a) (i) List any TWO errors associated with Very High Frequency omni range (VOR).
- (ii) With the aid of a labelled diagram, explain the operation of an Instrument Landing System (ILS). (9 marks)
- (b) Draw a labelled diagram of a waveguide taper/coaxial line coupling and describe its operation. (4 marks)
- (c) A waveguide, with an internal width of 4 cm, has a characteristic wave impedance of  $600\Omega$ . If the signal carried is the dominant mode, determine:
- (i) the cut-off wavelength.
- (ii) the frequency of the signal. (7 marks)
6. (a) (i) List any TWO disadvantages of the filter method, over the phasing method of generating a single sideband (SSB) signal.
- (ii) With the aid of a circuit diagram, explain the operation of a High Frequency (HF) transmitter/antenna coupler. (8 marks)
- (b) Draw a labelled block diagram of an Independent sideband (ISB) transmitter and describe its operation. (8 marks)
- (c) A double sideband AM transmitter radiates 100 KW at a modulation index of 0.8. If the carrier and one sideband were suppressed after modulation by a signal producing an average depth of 25%, determine the power output in the remaining sideband. (4 marks)
7. (a) Define the following with respect to radar systems:
- (i) maximum unambiguous range.
- (ii) angular resolution. (2 marks)

- (b) (i) With the aid of a circuit diagram, describe the operation of a live pulser radar modulator.
- (ii) Draw a labelled block diagram of a distance measuring equipment secondary radar system and describe its operation. (13 marks)
- (c) A radar system operates at 9 GHz with a pulse repetition frequency of 800 pulses per second. Determine the lowest three blind speeds for the system. (5 marks)

8. (a) Define the following as applied to data communications:

- (i) equalization .
- (ii) quantization noise. (2 marks)

(b) With the aid of labelled diagrams, describe the following data network topologies:

- (i) star.
- (ii) ring. (8 marks)

(c) With the aid of circuit diagrams, explain the operation of the following data networks:

- (i) a 1-of-4 multiplexer.
- (ii) a 4-bit parity generator. (10 marks)