EAST AFRICAN SCHOOL OF AVIATION
EXAMINATION

END TERM I EXAMS

DIPLOMA IN AERONAUTICAL ENGINEERING AVIONICS

COMMUNICATION AND TELECOMMUNICATION SYSTEMS

STREAM: Module II (Avionics) **Duration:**

DAY/DATE: **TIME:**

INSTRUCTION TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Mathematical tables/ Electronic calculator.

*Answer **ANY THREE QUESTIONS IN SECTION A** and **ANY TWO IN SECTION B** in this paper*

All questions carry equal marks.

Maximum marks for each part of a question are as shown

This paper consists of Seven (7) 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 (TELECOMMUNICATION PRINCIPLES)

1. (a) A piece of RG-59BIUcoaxial cable has 75Ωcharacteristic impedance and a nominal capacitance of 69 pF/m. What is its inductance per unit meter? If the diameter of the inner conductor is 0.584 mm, and the dielectric constant of the insulation is 2.23, what is the outer conductor diameter? **(5 marks)**

   (b) It required to match a 200-Ω Load to a 300-Ω transmission line, to reduce the SWR along the line to 1. What must be the characteristic impedance of the quarter-wave transformer used for this purpose, if it is connected directly to the load? **(4 marks)**

   (c) A (200 + j75)-Ω load is to be matched to a 300-Ω line to give SWR = 1. Calculate the reactance of the stub and the characteristic impedance of the quarter-wave transformer, both connected directly to the load. **(5 marks)**

   (d) A load Z_L = (100 - j50) Ω is connected to line whose Zo =*7S* Ω. Calculate:-

      (i) The point, nearest to the load, at which a quarter-wave transformer may be inserted to provide correct matching **(3 marks)**

      (ii) The Z'o of the transmission line to be used for the transformer **(3 marks)**

2. (a) An antenna has an impedance of 40Ω. An unmodulated AM signal produces a current of 4.8 A. The modulation is 90 percent. Calculate:

      (i) The carrier power. **(3 marks)**

      (ii) The total power. **(3 marks)**

      (iii) The sideband power. **(2 marks)**

   (b) (i) Explain why modulation is necessary or desirable. **(3 marks)**

      (ii) In AM, how does the carrier vary in accordance with the information signal? **(3 marks)**

(iii) Explain the effects of a modulation percentage greater than 100. **(3 marks)**

(iv) What three signals can be added to give an AM wave? **(3 marks)**

3. (a) From Bessel Functions table below, draw FM signal spectra with:

(i) Modulation index of 0 **(1 mark)**

(ii) Modulation index of 1. **(4 marks)**

(iii) Modulation index of 2. **(5 marks)**

(iv) Modulation index of 0.25 **(2 marks)**

Modulation Index	Carrier	Sidebands (Pairs)															
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—	—
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—	—
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—	—
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—	—
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—	—
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	−0.11	−0.29	−0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	—	—
9.0	−0.09	0.24	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	—	—	—
10.0	−0.25	0.04	0.25	0.06	−0.22	−0.23	−0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01	—	—
12.0	−0.05	−0.22	−0.08	0.20	0.18	−0.07	−0.24	−0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01
15.0	−0.01	0.21	0.04	0.19	−0.12	0.13	0.21	0.03	−0.17	−0.22	−0.09	0.10	0.24	0.28	0.25	0.18	0.12

(b) From Bessel Functions table State the amplitudes of the carrier and first four sidebands of an FM signal with a modulation index of 4. **(4 marks)**

(c) What is the maximum bandwidth of an FM signal with a deviation of 30 kHz and a maximum modulating signal of 5 kHz as determined by:-

(i) From Bessel Functions table

(ii) Carson's rule? **(4 marks)**

4. (a) (i) There are four major functions that must be fulfilled by antenna couplers (the fourth of which does not always apply). What are they? **(4 marks)**

(ii) Explain fully what is meant by the term resonant antenna. **(3 marks)**

(b) A half-wave dipole antenna is capable of radiating l-kW and has a 2.I5-dB gain over an isotropic antenna. How much power must be delivered to the isotropic (omnidirectional) antenna, to match the field-strength directional antenna? **(4 marks)**

(b) If an antenna has a field gain (expressed in voltage) of 2 and the transmitter has an overall efficiency of 50 percent (the circuit and transmission line losses) then, if a l-kW signal is fed to the finals, this will result in 500 W being fed to the antenna. What is the erp? **(3 marks)**

(c) With the aid of appropriate sketches, explain fully the operation of a Yagi-Uda array. List its applications. Why is it called a super gain antenna? **(6 marks)**

SECTION B (COMMUNICATION SYSTEMS)

5. (a) (i) Define amplitude modulation. **(1 Mark)**

(ii) Give the expression for AM wave. **(1 Mark)**

(iii) Define Modulation index of an A.M. signal. **(1 Mark)**

(iv) A DSB-FC transmitter supplies 8 Kw to the antenna when unmodulated. Determine the total power radiated when modulated to 30%. **(4 Marks)**

(v) What is the % power saving in DSB-SC-AM and SSB-SC AM of the DSB-FC signal in (iv)? **(3 Marks)**

(b) A 25 MHz carrier is modulated by a 400 Hz audio sine wave. If the carrier voltage is 4V and the maximum frequency deviation is 10 kHz, write down the voltage equation of the FM wave. **(3 Marks)**

(c) Calculate the modulation index for an FM wave where the maximum frequency deviation is 50 kHz and the modulating frequency is 5 kHz. **(3 Marks)**

(d) The carrier frequency in an FM modulator is 1000 kHz. If the modulating frequency is 15 kHz, what are the first three upper sideband and lower sideband frequencies? **(4 Marks)**

6. (a) The carrier and modulating frequencies of an FM transmitter are 100 MHz and 15 kHz respectively. If the maximum frequency deviation is 75 kHz, find the bandwidth of FM signal. **(4 Marks)**

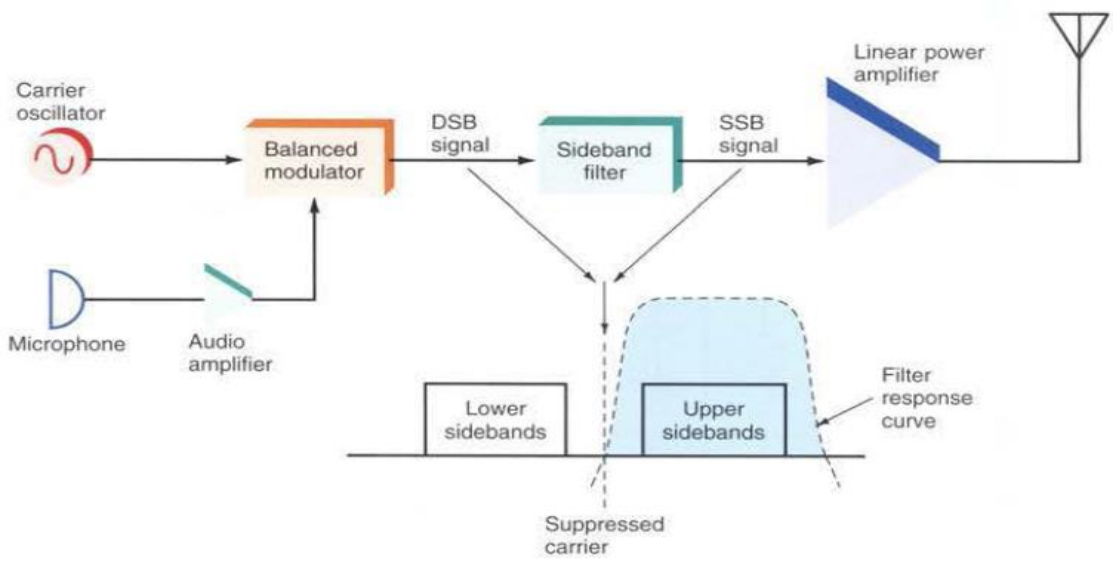
(b) In a frequency modulated wave, frequency deviation constant is 75 kHz/volt and the signal amplitude is 2V. Find the maximum frequency deviation. **(4 Marks)**

(c) In an FM system, when the audio frequency (AF) is 500 Hz and the AF voltage is 2.4V, the frequency deviation is 4.8 kHz. If the AF voltage is now increased to 7.2V, what is the new frequency deviation? If the AF voltage is raised to 10V while the AF is dropped to 200 Hz, what is the deviation? Find the modulation index in each case. **(12 Marks)**

7. (a) An SSB transmitter using the filter method of below operates at a frequency of 4.2 M Hz. The voice frequency range is 300 to 3400 Hz.

(i) Calculate the upper and lower sideband ranges.

(ii) What should be the approximate center frequency of a bandpass filter to select the lower sideband? **(10 marks)**



(b) An SSB signal is generated by modulating a 5-MHz carrier with a 400-Hz sine tone. At the receiver, the center frequency of the filter needed to pass the lower sideband is? **(3 marks)**

(c) A 1496 IC balanced modulator has a carrier-level input of 200 mV. The amount of suppression achieved is 60 dB. How much carrier voltage appears at the output? Carrier is reinserted during demodulation, but its frequency is 5.00015 MHz rather than exactly 5 M Hz. How does this affect the recovered signal'? How would a voice signal be affected by a carrier that is not exactly the same as the original? **(7 marks)**

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