UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRONIC COMMUNICATION II**
CODE	:	**AEC 2221**
DATE	:	WINTER MAIN EXAMINATION 2 JUNE 2018
DURATION	:	(SESSION 1) 8:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	DR AA ALONGE
MODERATOR	:	DR GR AIYETORO
NUMBER OF PAGES	:	6 PAGES AND 1 SMITH CHART

INSTRUCTIONS TO ALL STUDENTS

1. ATTEMPT ALL QUESTIONS.
2. TOTAL MARKS = 100%.
3. MARKS WILL BE DEDUCTED FOR UNATTRACTIVE AND UNREADABLE WORK.
4. DIAGRAMS AND SKETCHES MUST BE DRAWN NEATLY.
5. DIAGRAMS AND SKETCHES MUST BE LABELLED CORRECTLY.
6. QUESTIONS MAY BE ANSWERED IN ANY ORDER, BUT ALL PARTS OF THE QUESTION MUST BE GROUPED TOGETHER
7. **QUESTION PAPERS MUST BE HANDED IN WITH EXAMINATION SCRIPTS**

QUESTION 1: COMMUNICATION SYSTEMS

1.1 Define and describe the following concepts in communication system:

(a) Bandwidth

(b) Thermal noise (4)

1.2 Calculate the required channel capacity for a X-band satellite system with transponder operating at 40 MHz bandwidth with a signal-to-noise ratio (SNR) of 20 dB. (4)

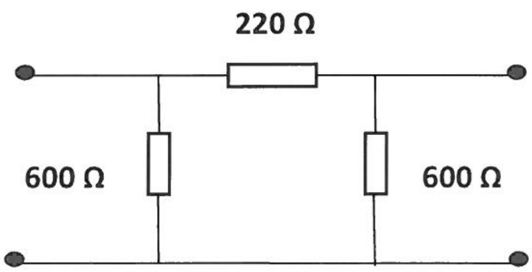
1.3 Identify and discuss any four factors affecting channel considerations in communication systems. (8)

1.4 For an amplifier with an output signal power of 20 W and an output noise power of 0.05 W, determine the signal to noise power ratio. What is the decibel equivalent of the SNR? (3)

[19]

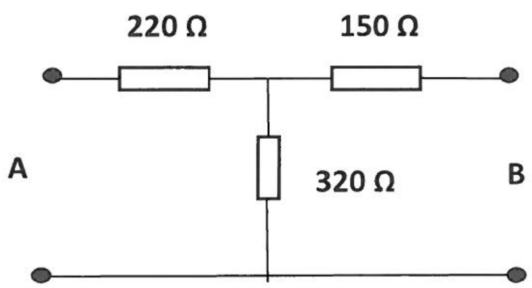
QUESTION 2: TWO-PORT NETWORKS

2.1 Determine the characteristic impedance and attenuation of the Π-network below:



(4)

2.2 Define the term "image impedance" and calculate the image impedance found at both terminals A and B of the asymmetrical circuit below:



(6)

2.3 Design a symmetrical attenuator pad to give 15 dB attenuation with characteristic impedance of 250 Ω. For these specifications, draw out the circuit arrangements for the unbalanced versions of T and Π networks. (8)

[18]

QUESTION 3: TRANSMISSION LINES

3.1 Describe the following terminologies with respect to transmission lines:

(a) Primary constants, and, (2)

(b) Secondary constants (2)

3.2 The input impedance of a transmission line 1 km long is $1500\angle 16^{\circ}$ Ω with the distant end open circuited and $120\angle -25^{\circ}$ Ω with the distant end short circuited, operating at 1500 Hz. If the propagation constant is $0.500\angle 65^{\circ}$ per km, calculate:

3.2.1 The characteristic impedance of the transmission line (2)

3.2.2 The primary constants of this transmission line. (4)

3.3 A 200 - j120-Ω load is connected to a 75-Ω lossless transmission line. Using the provided Smith chart, determine the following parameters of this communication system.

(a) Reflection Coefficient, Γ (2)

(b) Voltage Standing Wave Ratio (VSWR) (2)

(c) The load admittance, Y_L (2)

[16]

QUESTION 4: FILTERS

4.1 Show that the characteristic impedance for a constant-k, T-type Low Pass Filter (LPF) with an inductance, *L*, and capacitance, *C*, is mathematically given by:

$$Z_O = \sqrt{\frac{L}{C}\left(1 - \frac{\omega^2}{{\omega_c}^2}\right)}$$

(4)

4.1.1 Calculate the cut-off frequency in (4.1) given that $L = 1$ mH and $C = 1$ μF. (2)

4.1.2 What happens to Z_O when a frequency of 15 kHz is applied? Explain your result. (3)

4.2 Design a Π-type High Pass Filter (HPF) with a cut-off frequency of 10 kHz for a 120 Ω transmission line. Draw out the circuit. (5)

[14]

QUESTION 5: MODULATION

5.1 Mention two reasons why modulation is necessary in electronic communication. (2)

5.2 Discuss two digital modulation techniques (4)

5.3 For an AM DSBFC modulator with a carrier frequency f_c = 200 kHz and a maximum modulating signal frequency $f_{m(max)}$ = 10 kHz, determine:

5.3.1 Frequency limits for the upper and lower sidebands. (2)

5.3.2 Bandwidth (2)

5.3.3 Draw out the output frequency spectrum (2)

[12]

QUESTION 6: ANTENNAS

6.1 Define the following terms:

6.1.1 Vertical waves

6.1.2 Horizontal waves

6.1.3 Antenna bandwidth (6)

6.2 Explain how an increase or decrease in the length of an antenna affects the resonant frequency (2)

6.3 What is the length of the following vertical antennas?

6.3.1 A quarter-wave antenna operating at a frequency of 400 MHz

6.3.2 A half-wave antenna operating at a frequency of 25 MHz (4)

[12]

QUESTION 7: RADIO COMMUNICATIONS AND PROPAGATION

7.1 Define the term propagation with respect to electronic communication. (3)

7.2 Differentiate between sky waves and space waves. (6)

[9]

##

FULL MARK TOTAL = 100 MARKS

##

Some Useful Physical Constants

Velocity of light in vacuum = 2.988×10^{8} m/s
Boltzmann constant = 1.381×10^{-23} J/k
Permeability of free space = $4\pi \times 10^{7}$ H/m
Permuttivity of free space = 8.854×10^{-12} F/m

Some Useful Formulas

Channel Capacity = $B\log_2(1+snr)$

$velocity = f\lambda$

$$\lambda = \frac{2\pi}{\beta}$$

dB-milliwatt = *dB-watt* + *30*

Thermal noise (Watts)= *KTB*

decibels = 8.686 x *nepers*

$$Z_o = \sqrt{Z_{sc}Z_{oc}}$$

$$\gamma = \alpha + j\beta$$

$$v_p = \frac{\omega}{\beta}$$

$$Z_o = \sqrt{\frac{R+j\omega L}{G+j\omega C}}$$

$$\gamma = \sqrt{(R+j\omega L)(G+j\omega C)}$$

$$Z_{in} = Z_o\left[\frac{Z_L + jZ_oTan\,\beta l}{Z_o + jZ_LTan\,\beta l}\right]$$

$$\Gamma = \frac{V_{reflected}}{V_{incident}}$$

$$\Gamma = \frac{Z_L - Z_o}{Z_L + Z_o}$$

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

$$m_f = \frac{\Delta \mathrm{f}}{\mathrm{fm}}$$

$$Bandwidth = 2(\Delta\mathrm{f} + \mathrm{f_m})$$

$$m_t = \sqrt{m_1^2 + m_2^2 + m_3^2 + m_4^2}$$

$$P_{LSB} = P_{USB} = \frac{m_t^2}{4}P_C$$

$$P_C = \frac{E_c^2}{2R}$$

$$m = \frac{E_m}{E_c},\ m\ is\ the\ modulation\ index$$

π-Network specifications

$$Z_{o\pi} = \frac{Z_1Z_2}{\sqrt{Z_1Z_2 + \frac{Z_1^2}{4}}}$$

$$\alpha_{dB} = 20\log N = 20\log\left(1 + \frac{Z_1}{2Z_2} + \frac{Z_1}{Z_o}\right)$$

$$2R_2 = \frac{R_o(N-1)}{N+1}$$

$$R_1 = \frac{R_o(N^2-1)}{2N}$$

T-Network specifications

$$Z_{oT} = \sqrt{Z_1Z_2 + \frac{Z_1^2}{4}}$$

$$\alpha_{dB} = 20\log N = 20\log\left(1 + \frac{Z_1}{2Z_2} + \frac{Z_o}{Z_2}\right)$$

$$\frac{R_1}{2} = \frac{R_o(N-1)}{N+1}$$

$$R_2 = \frac{R_o(2N)}{N^2-1}$$

$$Z_{o\pi} = \frac{Z_1Z_2}{Z_{oT}}$$

Low Pass Filter

$$L = \frac{R_o}{\pi f_c}$$

$$C = \frac{1}{\pi R_o f_c}$$

$$f_c = \frac{1}{\pi\sqrt{LC}}$$

High Pass Filter

$$L = \frac{R_o}{4\pi f_c}$$

$$C = \frac{1}{4\pi R_o f_c}$$

$$f_c = \frac{1}{4\pi\sqrt{LC}}$$

Iterative Impedance

$$Z_{01} = \frac{(Z_2 - Z_1) \pm \sqrt{(Z_1 + Z_2)(Z_1 + Z_2 + 4Z_3)}}{2}$$

$$Z_{02} = \frac{(Z_1 - Z_2) \pm \sqrt{(Z_1 + Z_2)(Z_1 + Z_2 + 4Z_3)}}{2}$$

Image Impedance

$$Z_A = \sqrt{\frac{Z_1 + Z_3}{Z_2 + Z_3}(Z_1Z_2 + Z_1Z_3 + Z_2Z_3)}$$

$$Z_B = \sqrt{\frac{Z_2 + Z_3}{Z_1 + Z_3}(Z_1Z_2 + Z_1Z_3 + Z_2Z_3)}$$

Half-section Network

$$R_1 = \sqrt{R_A(R_A - R_B)}$$

$$R_2 = \sqrt{\frac{R_A {R_B}^2}{(R_A - R_B)}}$$

$$\alpha = 10 \log \frac{(R_1 + R_A)^2}{R_A R_B}$$

HEARST
Electronic
PRODUCTS

TITLE	
NAME	DATE