NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
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POTCHEFSTROOMKAMPUS

Benodigdhede vir hierdie vraestel/Requirements for this paper:				Oopboek-eksamen/ Open book examination?	NEE/ NO
Multikeusekaarte/ Multi-choice cards:		Nie-programmeerbare sakrekenaar/ Non-programmable calculator:	X		
Grafiekpapier/ Graph paper:		Draagbare Rekenaar/ Laptop:			

EKSAMEN EXAMINATION	**Eksamen 1** *Examination 1*	**KWALIFIKASIE/ QUALIFICATION:**	**B. Ing / B. Eng**
MODULEKODE/ MODULE CODE:	**EERI 423**	**TYDSDUUR/ DURATION:**	**3 ure/hours**
MODULEBESKRYWING/ MODULE DESCRIPTION:	**Telekommunikasie / Telecommunication**	**MAKS/ MAX:**	**103**
EKSAMINATOR(E)/ EXAMINER(S):	**Prof Johann Holm** **Mnr Christo van der Merwe**	**DATUM/ DATE:**	**16/11/2015**
		TYD/TIME:	**09:00**
MODERATOR:	**Mnr Carl Thom**		

Vraag 1: Algemene vrae / Question 1: General questions [11]

1.1 Beantwoord die volgende kortvrae: / *Answer the following short questions:*

(a) Gee die verskil tussen basisband en wyeband kommunikasie. / *Give the difference between baseband and broadband communication.* [2]
(b) Wat word gedoen om meer as 1 bis op 'n slag oor 'n radiokanaal te stuur – verduidelik baie kortliks? / *What is done to transmit more than 1 bit at a time over a radio channel – briefly explain?* [2]

1.2 Bereken die kwantiseringsruis (in dBm) van 'n 8-bis A/D omsetter met 'n spanningsbereik van 5 Volt in 'n las van 1 kΩ (werk eers die WGK ruisspanning uit). / *Calculate the quantizing noise (in dBm) of an 8-bit A/D converter with a voltage range of 5 Volt into a load of 1 kΩ (first calculate the RMS noise voltage).* [7]

Vraag 2: Versenders en ontvangers / Question 2: Transmitters and receivers [36]

2.1 Gee die blokdiagram van 'n moderne digitale versender en benoem elke element op die diagram. / *Give the block diagram of a modern digital transmitter and name each element on the diagram.* [11]

2.2 Teken 'n blokdiagram van 'n direkte digitale sintetiseerder en beskryf die funksie van elkeen van die 5 komponente op die diagram volledig. / *Draw a block diagram of a direct digital synthesizer and comprehensively describe the function of each of the 5 components on the diagram.* [10]

2.3 'n Ontvanger met 'n 50 Ω insetimpedansie werk by 'n temperatuur van 290 K. 'n RF sein word ontvang met 'n bandwydte van 2 MHz. Die seinvlak by die ontvanger is 2 μV_{RMS} en die ontvanger het 'n saamgestelde ruistal van 3.5 dB. / *A receiver with a 50 Ω input impedance works at a temperature of 290 K. A signal is received with a bandwidth of 2 MHz. The signal level at the receiver is 2 μV_{RMS} and the receiver has a noise figure of 3.5 dB.*

(a) Bereken die ruisdrywing. / *Calculate the noise power.* [2]
(b) Bereken die seindrywing. / *Calculate the signal power.* [2]
(c) Wat is die sein-tot-ruis verhouding voor die ontvanger? / What is the signal-to-noise ratio before the receiver? [2]
(d) Wat is die sein-tot-ruis verhouding by die uitset van die ontvanger? / *What is the signal-to-noise ratio at the output of the receiver?* [2]

2.4 Beantwoord die volgende kortvrae: / Answer the following short questions:

(a) Verduidelik "software defined radio (SDR)" kortliks. Geen diagramme word benodig nie. / *Briefly explain software defined radio (SDR). No diagrams are required.* [2]
(b) Wat is die doel van 'n menger in 'n digitale sintetiseerder? / *What is the purpose of a mixer in a digital synthesizer?* [2]
(c) Wat is die doel van automatiese winsbeheer in ontvangers? / *What is the purpose of automatic gain control in receivers?* [3]

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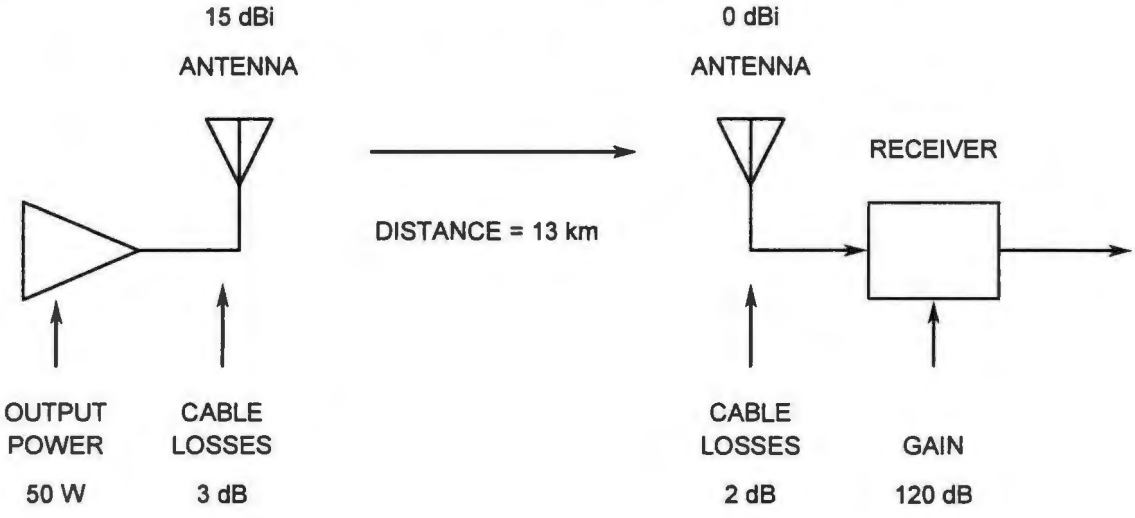
Vraag 3: Kommunikasiestelsels / Question 3: Communications systems [14]

3.1 Gee en beskryf die 2 **dupleksering**stegnieke wat gebruik word vir dupleks kommunikasie. Wat is die voordele en nadele van elk i.t.v. koste en spektrum? / *List and describe the 2* ***duplexing*** *techniques used for duplex communication. What are the advantages and disadvantages of each i.t.o. cost and spectrum?* [6]

3.2 Teken en benoem elke element in die blokdiagram van 'n QPSK demodulator. / *Draw and name each element in the block diagram of a QPSK demodulator.* [8]

Vraag 4: Ontvangers en padverlies / Question 4: Receivers and path loss [15]

4.1 'n Versender en ontvanger het die volgende komponente met winste en verliese soos aangedui, beantwoord die vrae wat daarna volg: / *A transmitter and receiver have the following components with gains and losses as indicated, answer the questions that follow:*



- Log-afstand padmodel / *Log-distance path model*;
- Sein-tot-ruis verhouding voor ontvanger = 21 dB / *Signal-to-noise ratio before receiver = 21 dB*;
- Sein-tot-ruis verhouding na ontvanger = 19 dB / *Signal-to-noise ratio after receiver = 19 dB*;
- PL(d0): 33 dB by 1m / *at 1m;*
- Padverlieskonstante / *Path loss constant:* 3.5.

Beantwoord die volgende: / *Answer the following:*

(a) Wat is die ruistal van die ontvanger – is dit 'n goeie ruistal (verduidelik)? / *What is the noise figure of the receiver – is it a good noise figure (explain)?* [3]
(b) Bereken die padverlies deur die ruimte (soos aangedui). / Calculate the path loss through space (as indicated). [2]
(c) Bereken die drywing voor die ontvanger (na die antenne en kabels) en na die ontvanger in dBm. / *Calculate the power before (after the antenna and cables) and after the receiver in dBm.* [4]
(d) Wat sal die kommunikasie-afstand wees in die vrye ruimte om dieselfde padverlies te gee as in (b) – is dit haalbaar (gee 'n verduideliking)? Gebruik die log-normale padverlies uitdrukking. / *What would the communication distance be in free space to give the same path loss as in (b) – is this achievable (give an explanation)? Use the log-normal path loss expression.* [6]

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Vraag 5: Sellulêre stelsel beginsels / Question 5: Cellular system principles [27]

5.1 'n Sellulêre stelsel moet aan die Bult voorsien word deur netwerk ABC. Die volgende is bekend: / *A cellular system must be provided to the Bult area by network ABC. The following is known*:

- Aantal gebruikers = 120,000 / *Number of users = 120,000*
- Daar is 4 selle per bondel ("cluster") / *There are 4 cells per cluster*
- Blokkering sal gebruik word met 2% oproepe wat geblokkeer en skoongemaak sal word / *Call blocking will be used with 2% blocked calls cleared*
- Die huidige diensverskaffer het 280 radiokanale beskikbaar vir spraak / *The current service provider has 280 radio channels available for voice*
- Gedurende die besige uur bel die gemiddelde gebruiker 3 maal per uur en elke oproep duur 3 minute / *During busy hour, the average user calls 3 times per hour with each call lasting 3 minutes*
- Die geografiese area van die Bult is ongeveer 100 km^2. Elke sel het 'n radius van 0.8 km / *The geographical area of the Bult is approximately 100 km^2. Each cell has a radius of 0.8 km*

(a) Hoeveel gebruikers kan PER SEL hanteer word in die besige uur met die stelsel? / *How many users can be supported PER CELL in the busy hour with the system?* [7]
(b) Hoeveel selle is daar in die Bult area? / *How many cells are there in the Bult area?* [3]
(c) Hoeveel gebruikers kan in TOTAAL hanteer word met die huidige stelsel? / *In TOTAL, how many users can be supported with the current system?* [1]
(d) Spraakkanele kos R100,000 per kanaal en nuwe selle kos ongeveer R500,000 per sel – wat moet die netwerk ABC kies om die hele Bult te kan bedien? Maak aannames waar nodig. / *Speech channels cost R 100,000 per channel and cells cost R500,000 per cell – what must network ABC do to service the whole of the Bult? Make assumptions where necessary.* [6]

5.2 'n Sellulêre stelsel benodig 'n sein-tot-interferensie (S/I) van ten minste 15 dB om goeie spraakgehalte te verseker. Geen sektorisering teenoor 120° sektorisering word oorweeg as opsies. Wat is die beste bondelgroottes ("cluster sizes") wat die probleem sal aanspreek indien die padverlieskonstante n = 4 is? Toon berekeninge vir beide opsies en stel die beste opsie voor. / *A cellular system requires a signal-to-interference (S/I) of at least 15 dB to ensure good speech quality. No sectoring as opposed to 120° sectoring are considered as options. What is the best cluster sizes to address this problem if the path loss constant is n = 4? Show calculations for both options and propose the best option.* [10]

TOTAAL/TOTAL: 103

EERI423 FORMULEBLAD VIR NOVEMBER 2015
EERI423 FORMULA SHEET FOR NOVEMBER 2015

Ontvangers, versenders en ruis / *Receivers, transmitters, and noise*

$$v_n = \sqrt{4kTBR} \qquad P_n = kTB$$

$$k = 1.38\times10^{-23}\ J/K \qquad i_n = \sqrt{2qI_{DC}B}$$

$$q = 1.6\times10^{-19}\ \text{C} \qquad S/N = \frac{Ps}{Pn}$$

$$NR = NR_1 + \frac{NR_2 - 1}{A_{P1}} + \frac{NR_3 - 1}{A_{P1}\cdot A_{P2}} + \frac{NR_4 - 1}{A_{P1}\cdot A_{P2}\cdot A_{P3}} + \cdots \qquad T_N = 290(NR - 1)$$

$$R = MN + A \qquad NR = \frac{S/N_{INPUT}}{S/N_{OUTPUT}}$$

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