



**Strathmore**  
UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES  
BACHELOR OF COMPUTER NETWORKS AND CYBER SECURITY  
END OF SEMESTER EXAMINATION

CNS3106: WIRELESS COMMUNICATION

DATE: 1<sup>st</sup> August 2024

Time: 8.00-10.00Hours

**Instructions**

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

**QUESTION ONE (30 MARKS-COMPULSARY)**

- a) Table 1 shows the specifications of two antennas A and B.
- i. With reasons, state which antenna has
    - I. Better penetration of obstacles; **(2 marks)**
    - II. Higher data capacity ; **(2 marks)**
  - ii. Obtain the difference in the gain of antenna A and antenna B in dBi **(2 marks)**
  - iii. Explain the significance of each of the following antenna parameters and comment on the relative values between the two antennas
    - I. Polarization;
    - II. Radiation resistance;**(4 marks)**

**Table 1**

Parameters	Antenna A	Antenna B
Frequency range	10.3-11.7 GHz	2.4-2.483 GHz
Gain	36 dBi	16.15 dBd
Front-to-back (F/B) ratio	60 dB	>28dB
Polarization	Default: Vertical/Horizontal	Vertical
Maximum VSWR	2:1	$\leq 1.5$
Radiation resistance	100 $\Omega$	50-70 $\Omega$

- b) State **THREE** methods of increasing the cellular network capacity. **(3 marks)**
- c) Explain why the uplink duplex frequency is lower than the downlink duplex frequency between the Base Transceiver Station (**BTS**) and the mobile station (**MS**). **(2 mark)**
- d) In a single cell system each user generates on the average 3.5 calls per hour and each call lasts on average 150 seconds. Determine the traffic intensity for each user**(3 marks)**

- e) Describe each of the following with respect to Bluetooth Technology
- i. Piconet;
  - ii. Scatternet.
- (6 marks)**
- f) You are given the following terminals to connect in a WiFi4 (IEEE 802.11 )
- Mobile station
  - Access point
  - Desktop computer
  - Router
- Sketch the layout of the network
- (2 marks)**
- g) Describe the following wave propagation mechanisms
- i. Reflections;
  - ii. Diffraction.
- (4 marks)**

**QUESTION 2 (15 MARKS)**

- a) State ONE function of each of the following components in a cellular network
- i. Base Transceiver Station (BTS) ; **(1 marks)**
  - ii. Base Station Controller (BSC) . **(1 marks)**
- b) An area to be covered by a cellular network has the parameters shown in Table 2

Table 2

Parameters	Values
Area	10,000 km <sup>2</sup>
Population	2.5 Million
Cell frequency reuse	12
Allotted spectrum for the area	20 MHZ
Channel spacing	70khz
Cell radius	3.06 km

Assume grade of service (GOS) of 2 per cent for an Erlang B system is specified if the offered traffic per user is 0.03 Erlangs. Determine each of the following:

- i. Number of channels per cell ; **(3 marks)**
  - ii. Traffic intensity of each cell ; **(2 marks)**
  - iii. Total number of cells ; **(2 marks)**
  - iv. Maximum carried traffic; **(2 marks)**
  - v. Total number of users served for 2% grade of service . **(2 marks)**
- c) Distinguish between fixed and dynamic frequency assignments in cellular networks **(2 marks)**

**QUESTION 3 (15 MARKS)**

- a) An antenna has a radiation resistance and loss resistance of  $72\Omega$  and  $10\Omega$  respectively. The power gain of the antenna is 28. Determine each of the following:
- Efficiency ; **(2 marks)**
  - Directivity . **(2 marks)**
- b) A geostationary satellite is transmitting a TV signal to an earth based station at a distance of  $4000km$ . Assume that the dish antennas of the satellites and the earth station have dimensions of  $0.5m$  and  $5m$  respectively and their aperture efficiencies are 60 %. If the satellite transmit power is  $6W$  and the downlink frequency is  $4GHz$ , determine the:
- Gain of each antenna in dB ; **(7 marks)**
  - Received power in dB . **(4 marks)**

**QUESTION 4 (15 MARKS)**

- a) With the aid of sketches, distinguish between end-fire array and broadside array. **(5 marks)**
- b) With respect to a Yagi-Uda antenna array. State the
- effect of increasing the number of reflectors;
  - effect of increasing the number of directors;
  - reason why the driven dipole is folded;
  - typical areas of application of the antenna. **(4 marks)**
- c) With respect to WiMAX network architecture, describe each of the following components **(6 marks)**
- Mobile Station, MS;
  - Access Service Network, ASN;
  - Connectivity Service Network, CSN;

**QUESTION 5 (15 marks)**

- a) With the aid of diagrams, describe the three device types in Zigbee network **(6 marks)**
- b) With the aid of layered protocol diagram, show the mapping of Bluetooth protocols to that of the OSI model, up to the data link layer. **(3 marks)**
- c) Describe each of the following with respect to Wi-Fi architecture
- Access point, AP;
  - Basic Service Set (BSS);
  - Extended Service Set, ESS. **(6 marks)**

Erlang Tables and Formulae sheet

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**Erlang B Table**

S/B	0.01%	0.05%	0.1%	0.5%	1%	2%	5%	10%	15%	20%	30%	40%
1	.0001	.0005	.0010	.0050	.0101	.0204	.0526	.1111	.1765	.2499	.4285	.6666
2	.0142	.0321	.0457	.1053	.1526	.2234	.3813	.5954	.7962	.9999	1.449	2.000
3	.0868	.1517	.1938	.3490	.4554	.6022	.8994	1.271	1.602	1.930	2.633	3.480
4	.2347	.3623	.4393	.7012	.8694	1.092	1.525	2.045	2.501	2.945	3.890	5.021
5	.4519	.6486	.7621	1.132	1.361	1.657	2.218	2.881	3.454	4.010	5.188	6.595
6	.7282	.9956	1.146	1.622	1.909	2.276	2.960	3.758	4.444	5.108	6.513	8.190
7	1.054	1.392	1.578	2.157	2.501	2.935	3.738	4.666	5.461	6.230	7.856	9.799
8	1.422	1.830	2.051	2.730	3.127	3.627	4.543	5.597	6.498	7.369	9.212	11.42
9	1.826	2.302	2.557	3.333	3.782	4.345	5.370	6.546	7.551	8.521	10.58	13.04
10	2.260	2.803	3.092	3.960	4.461	5.084	6.215	7.510	8.616	9.685	11.95	14.68
11	2.721	3.329	3.651	4.610	5.160	5.841	7.076	8.487	9.691	10.86	13.33	16.31
12	3.207	3.878	4.231	5.279	5.876	6.614	7.950	9.474	10.78	12.04	14.72	17.95
13	3.713	4.446	4.830	5.963	6.607	7.401	8.834	10.47	11.87	13.22	16.11	19.60
14	4.239	5.032	5.446	6.663	7.352	8.200	9.729	11.47	12.96	14.41	17.50	21.24
15	4.781	5.634	6.077	7.375	8.108	9.009	10.63	12.48	14.07	15.61	18.90	22.89
16	5.339	6.250	6.721	8.099	8.875	9.828	11.54	13.50	15.18	16.81	20.30	24.54
17	5.911	6.878	7.378	8.833	9.651	10.66	12.46	14.52	16.29	18.01	21.70	26.19
18	6.496	7.519	8.045	9.578	10.44	11.49	13.38	15.55	17.40	19.21	23.10	27.84
19	7.092	8.169	8.724	10.33	11.23	12.33	14.31	16.58	18.52	20.42	24.51	29.50
20	7.700	8.831	9.411	11.09	12.03	13.18	15.25	17.61	19.65	21.63	25.92	31.15
21	8.318	9.501	10.11	11.86	12.84	14.04	16.19	18.65	20.77	22.85	27.32	32.81
22	8.946	10.18	10.81	12.63	13.65	14.90	17.13	19.69	21.90	24.06	28.73	34.46
23	9.583	10.87	11.52	13.42	14.47	15.76	18.08	20.74	23.03	25.28	30.14	36.12
24	10.23	11.56	12.24	14.20	15.29	16.63	19.03	21.78	24.16	26.50	31.56	37.78
25	10.88	12.26	12.97	15.00	16.12	17.50	19.98	22.83	25.30	27.72	32.97	39.43

( Area of a hexagon  $A = \frac{3\sqrt{3}R^2}{2}$  where R is the radius of the hexagon)

Speed of electromagnetic waves in free space  $c = 3 \times 10^8 \text{ m/s}$