

UNIVERSITY OF ESWATINI
MAIN EXAMINATION, FIRST SEMESTER DECEMBER 2019

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

**TITLE OF PAPER: TELECOMMUNICATIONS AND WIRELESS
SYSTEMS**

COURSE CODE: EEE541 / EE544

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

- 1. There are five questions in this paper. Answer any FOUR questions.
Each question carries 25 marks.**
- 2. If you think not enough data has been given in any question you may
assume any reasonable values.**

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GIVEN BY THE INVIGILATOR**

THIS PAPER CONTAINS NINE (9) PAGES INCLUDING THIS PAGE

QUESTION ONE (25 marks)

- (a) Describe briefly three multiple access methods used in digital satellite links.
(5 marks)
- (b) An earth station antenna receives signal with an attenuation of 9dB under rain. The cosmic noise temperature, physical temperature of the rain and the physical temperature of the earth are $60\text{ }^\circ\text{K}$, $280\text{ }^\circ\text{K}$ and $300\text{ }^\circ\text{K}$ respectively. If the efficiency of the antenna is 0.8, calculate the noise power at the output of antenna terminal in dBm . The signal bandwidth is 12MHz .
(8 marks)
- (c) A satellite link operating at 25GHz use an antenna having an elevation angle of 45° . The latitude of location is -40° . The 0.01% rain rate of an average year is $70\frac{\text{mm}}{\text{hr}}$. If the total link outage time throughout a year to be less than 25min , find the non diversity fade margin of the link. Assume that the other additional losses are 5dB .
(12 marks)

QUESTION TWO (25 marks)

- (a) (i) A geostationary satellite transmits 15GHz, signal using an antenna of gain 25dB. The gain of the earth receiver station antenna is 45dB. If the fade margin and the received signal strength are 8dB and $-90dBm$ respectively, find the transmitter power of the satellite in watts.

(8 marks)

- (ii) Estimate the Figure of Merit of the earth station receiver if it is connected to the antenna through a rectangular waveguide. You may use,

$$\text{Brightness temperature} = 80^{\circ}K$$

$$\text{Antenna efficiency} = 0.85$$

$$\text{Waveguide loss} = 2dB$$

$$\text{Physical temperature} = 25^{\circ}C$$

$$\text{Receiver noise figure} = 5dB$$

(8 marks)

- (b) The BER required at the output of a digital receiver is 10^{-5} . Find the signal power required at the input of the receiver if the data rate is $1.8 \frac{Mb}{s}$ and 8-PSK modulated.

Assume the following data,

$$\text{Signal to noise ratio at the receiver input} = 17dB.$$

$$\text{Receiver noise figure} = 5dB$$

$$\text{Bandwidth expansion factor} = 1.23$$

$$\text{FEC code rate} = \frac{2}{3}$$

(9 marks)

QUESTION THREE (25 marks)

- (a) In a mobile service, the cell radius and the cluster size used are 0.75km and 4.
- (i) Find the co-channel distance. (2 marks)
 - (ii) Calculate the $\frac{C}{I}$ ratio in dB . (2 marks)
 - (iii) Assuming 120° sectoring is used, find the carrier to co-channel interference ratio. (3 marks)
- (b) A 30MHz bandwidth is used for the forward channels of a mobile network. The cluster size is 4 and the GSM channel bandwidth is assumed. If BCC applies and the grade of service expected is 1% , estimate the number of customers that can be served in a cell. An average user makes a one call of 2min in a hour. (9 marks)
- (c) A mobile network covering large city area is operating in 900MHz band. If the transmitter power of the base station is 30W , find the path loss and the signal power received at a distance of 1.8km . Assume that the base station antenna is omni-directional. You may also use,
The height of the base station tower = 22m
The height of the mobile receiver = 1m (9 marks)

QUESTION FIVE (25 marks)

- (a) (i) A remote switch serving 650 subscribers is connected to an exchange serving national calls through a one *E1* line. A subscriber makes 2 calls of *3min* in the busy hour. If 30% of the traffic in the switch are national calls, find the blocking probability for the national call traffic. Assume that the BCC is employed.

(10 marks)

- (ii) A network receives 600 call requests during the busy hour. The average call duration per user is *2min* and the grade of service is 5%. Find,

- (i) Number of network trunks available.
- (ii) Number of lost calls.
- (iii) Amount of offered traffic.
- (iv) Amount of carried traffic.

(8 marks)

- (b) (i) Describe briefly a STM-1 frame ($155.52 \frac{Mb}{s}$) in SDH with useful data.

(4 marks)

- (ii) Identify SSP, STP, and SCP network parts in a SS7 network showing their interconnectivity.

(3 marks)

Erlang B Traffic Table

N/B	Maximum Offered Load Versus B and N											
	B is in %											
	0.01	0.05	0.1	0.5	1.0	2	5	10	15	20	30	40
1	.0001	.0005	.0010	.0050	.0101	.0204	.0526	.1111	.1765	.2500	.4286	.6667
2	.0142	.0321	.0458	.1054	.1526	.2235	.3813	.5954	.7962	1.000	1.449	2.000
3	.0868	.1517	.1938	.3490	.4555	.6022	.8994	1.271	1.603	1.930	2.633	3.480
4	.2347	.3624	.4393	.7012	.8694	1.092	1.525	2.045	2.501	2.945	3.891	5.021
5	.4520	.6486	.7621	1.132	1.361	1.657	2.219	2.881	3.454	4.010	5.189	6.596
6	.7282	.9957	1.146	1.622	1.909	2.276	2.960	3.758	4.445	5.109	6.514	8.191
7	1.054	1.392	1.579	2.158	2.501	2.935	3.738	4.666	5.461	6.230	7.856	9.800
8	1.422	1.830	2.051	2.730	3.128	3.627	4.543	5.597	6.498	7.369	9.213	11.42
9	1.826	2.302	2.558	3.333	3.783	4.345	5.370	6.546	7.551	8.522	10.58	13.05
10	2.260	2.803	3.092	3.961	4.461	5.084	6.216	7.511	8.616	9.685	11.95	14.68
11	2.722	3.329	3.651	4.610	5.160	5.842	7.076	8.487	9.691	10.86	13.33	16.31
12	3.207	3.878	4.231	5.279	5.876	6.615	7.950	9.474	10.78	12.04	14.72	17.95
13	3.713	4.447	4.831	5.964	6.607	7.402	8.835	10.47	11.87	13.22	16.11	19.60
14	4.239	5.032	5.446	6.663	7.352	8.200	9.730	11.47	12.97	14.41	17.50	21.24
15	4.781	5.634	6.077	7.376	8.108	9.010	10.63	12.48	14.07	15.61	18.90	22.89
16	5.339	6.250	6.722	8.100	8.875	9.828	11.54	13.50	15.18	16.81	20.30	24.54
17	5.911	6.878	7.378	8.834	9.652	10.66	12.46	14.52	16.29	18.01	21.70	26.19
18	6.496	7.519	8.046	9.578	10.44	11.49	13.39	15.55	17.41	19.22	23.10	27.84
19	7.093	8.170	8.724	10.33	11.23	12.33	14.32	16.58	18.53	20.42	24.51	29.50
20	7.701	8.831	9.412	11.09	12.03	13.18	15.25	17.61	19.65	21.64	25.92	31.15
21	8.319	9.501	10.11	11.86	12.84	14.04	16.19	18.65	20.77	22.85	27.33	32.81
22	8.946	10.18	10.81	12.64	13.65	14.90	17.13	19.69	21.90	24.06	28.74	34.46
23	9.583	10.87	11.52	13.42	14.47	15.76	18.08	20.74	23.03	25.28	30.15	36.12
24	10.23	11.56	12.24	14.20	15.30	16.63	19.03	21.78	24.16	26.50	31.56	37.78
25	10.88	12.26	12.97	15.00	16.13	17.51	19.99	22.83	25.30	27.72	32.97	39.44
26	11.54	12.97	13.70	15.80	16.96	18.38	20.94	23.89	26.43	28.94	34.39	41.10
27	12.21	13.69	14.44	16.60	17.80	19.27	21.90	24.94	27.57	30.16	35.80	42.76
28	12.88	14.41	15.18	17.41	18.64	20.15	22.87	26.00	28.71	31.39	37.21	44.41
29	13.56	15.13	15.93	18.22	19.49	21.04	23.83	27.05	29.85	32.61	38.63	46.07
30	14.25	15.86	16.68	19.03	20.34	21.93	24.80	28.11	31.00	33.84	40.05	47.74
31	14.94	16.60	17.44	19.85	21.19	22.83	25.77	29.17	32.14	35.07	41.46	49.40
32	15.63	17.34	18.21	20.68	22.05	23.73	26.75	30.24	33.28	36.30	42.88	51.06
33	16.34	18.09	18.97	21.51	22.91	24.63	27.72	31.30	34.43	37.52	44.30	52.72
34	17.04	18.84	19.74	22.34	23.77	25.53	28.70	32.37	35.58	38.75	45.72	54.38
35	17.75	19.59	20.52	23.17	24.64	26.44	29.68	33.43	36.72	39.99	47.14	56.04
36	18.47	20.35	21.30	24.01	25.51	27.34	30.66	34.50	37.87	41.22	48.56	57.70
37	19.19	21.11	22.08	24.85	26.38	28.25	31.64	35.57	39.02	42.45	49.98	59.37
38	19.91	21.87	22.86	25.69	27.25	29.17	32.62	36.64	40.17	43.68	51.40	61.03
39	20.64	22.64	23.65	26.53	28.13	30.08	33.61	37.72	41.32	44.91	52.82	62.69
40	21.37	23.41	24.44	27.38	29.01	31.00	34.60	38.79	42.48	46.15	54.24	64.35
41	22.11	24.19	25.24	28.23	29.89	31.92	35.58	39.86	43.63	47.38	55.66	66.02
42	22.85	24.97	26.04	29.09	30.77	32.84	36.57	40.94	44.78	48.62	57.08	67.68
43	23.59	25.75	26.84	29.94	31.66	33.76	37.57	42.01	45.94	49.85	58.50	69.34