The Open University of Sri Lanka
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
ECX4233 Communications 2011/2012
FINAL EXAMINATION **CLOSED BOOK**

DATE : 08-03-2012 **Time : 0930 - 1230**

Answer any 05 questions.

Q1.

(a) List the major planning tasks that are to be done when planning a telecommunication network. *[02]*

(b) Draw an outline of a telephone network in a country like Sri Lanka and clearly mark all components. *[04]*

(c) Describe the sequence of operations occur at subscriber's end as well as at the serving exchange in case of following situations:

1. When a subscriber's telephone instrument goes "Off Hook"
2. When a subscriber 'A' dials the telephone number of subscriber 'B' using pulse dialing
3. When a subscriber 'A' dials the telephone number of subscriber 'B' using tone dialing
4. When the subscriber B's telephone rings and he answers the call. *[08]*

(d) Differentiate the following:

(i) Junction circuits vs trunk circuits
(ii) Hierarchical routing vs. alternate routing
(iii) Local battery telephone system vs central battery telephone system *[06]*

Q2.

(a) Briefly explain the following signaling types used in common channel signaling:

(i) Associated signaling
(ii) Quasi-associated signaling
(iii) Non-associated signaling *[06]*

(b) (i) A 2-stage space-division full availability switching network acts as a concentrator. It has M incoming trunks, N outgoing trunks and N links between the two switching stages (where M>N). Number of switches in the second stage is twice as the number of switches in the first stage. Show the formation of each of the above switching network using a diagram. You need to mark all the necessary parameters. Obtain an expression for the total number of cross points. *[06]*

(ii) Use your result in part (b) to design a network for a 2-stage concentrator having 400 incoming trunks and 200 outgoing trunks. How many cross points does it contain? *[03]*

(iii) If you add a middle level with 9 switches to the above switching network in part (b)(ii), calculate the number of cross points required. Explain the advantage of increasing number of stages in a switching network. *[05]*

Q3.

(a) Define the following terms related to telephone traffic and discuss the significance of these factors in design and expansion of a telephone exchange

(i) Busy hour
(ii) Calling rate
(iii) Average holding time
(iv) Grade of service *[08]*

(b) Explain what you mean by the following facilities of a typical PABX.

(i) Follow me facility
(ii) Speed dialing
(iii) Call transferring
(iv) Conference facility *[04]*

(c) What considerations should be made when acquiring a PABX for a large organization? *[02]*

(d) During the busy hour, a particular group of circuits in a telephone exchange carried 600 calls. If the average holding time of a call is 3 minutes, calculate,

(i) the traffic volume
(ii) the traffic intensity
(iii) the average number of calls carried during the average holding time
(iv) the average number of calls in progress simultaneously *[06]*

Q4.

(a) Define the Erlang's B formula with clearly stating the assumptions made when deriving this formula. *[04]*

(b) A group of 5 trunks are offered 3E during the busy hour.

Find,
(i) Grade of service
(ii) Probability of only one trunk is free
(iii) Probability of only one trunk is busy
(iv) Probability of at least 1 trunk is busy
(v) Probability of more than one trunk are free *[10]*

(c) By using the given traffic table (page 5) find the number of trunks required for offered traffic of 5E, 8E and 10E for the following systems:

(i) Grade of service of 0.001
(ii) Grade of service for a 20% overload with the same number of trunks as in (c)(i). Use a table to show your answer. *[06]*

Q5.

(a) State 2 advantages and 2 disadvantages in digital transmission. *[02]*

(b) Explain the basic process of PCM using a block diagram. *[03]*

(c) For a resolution of 0.04 V, determine the voltages for the following linear 7-bit sign-magnitude PCM code (the leftmost bit represents the sign bit, 1 = ' + ' and 0 = ' - '):

(i) 1 1 1 0 1 0 1
(ii) 0 0 0 0 0 1 1
(iii) 0 0 0 0 0 0 1
(iii) 1 0 0 0 0 1 0 *[04]*

(c) "Pulse Code Modulation (PCM)", as used in telephony, samples a signal at 8kHz and uses 256 quantizing levels."

(i) Explain how the sampling rate is chosen.
(ii) If E1 TDM is used, draw the frame structure. You need to show all the details.
(iii) Hence find the data rate *[08]*

(d) Draw a sketch of STM-1 frame structure used in SDH. Hence show that STM-1 will carry 155.52Mbps. *[03]*

Q6.

(a) Compare the bandwidth, attenuation and interference immunity characteristics of the following transmission lines:

(i) Twisted-wire pair
(ii) Coaxial cable
(iii) Optical fibre *[06]*

(b) A matched telephone transmission line, 100km long has z_0= (685-j92) Ω, α = 0.00497 nepher/km and β = 0.0352 rad/km at 1 kHz. The power is supplied to the line by a generator with an e.m.f. of 10V r.m.s. and internal resistance of 700 Ω.

Calculate, (i) Sending end impedance
(ii) Propagation constant
(iii) Sending end voltage, current and power
(iv) Receiving end voltage, current and power *[14]*

Q7.

(a) Briefly explain the following terms related to transmission lines.

(i) Matched line
(ii) Standing wave
(iii) Reflection coefficient
(iv) VSWR *[04]*

(b) Consider a load impedance $Z_L = (100 - j25)\ \Omega$ connected to a transmission line which has a characteristic impedance of 50 Ω. If the electrical length of the line is $1/5\ \lambda$, find the following using Smith Chart.

(i) the voltage reflection coefficient
(ii) the VSWR
(iii) input impedance of the line
(iv) Input admittance of the line *[10]*

(c) If a short circuited stub is connected in series to match the line,

(i) Sketch a diagram showing how the stub is connected
(ii) Find the location and the length of the stub. *[06]*

Note: ***Use the Smith Chart given on page 6. You should clearly show how you get these values with sketches on the Smith Chart and attach it with the answer script.***

Q8.

(a) Describe the difference between stepped index multi-mode and mono-mode optical fibers. Illustrate your answer with diagrams showing the possible ray paths through the fiber in each case. *[04]*

(b) Draw the current and voltage distributions and horizontal and vertical radiation patterns of a half wave dipole. *[04]*

(c) Explain the advantage of adding parasitic elements to a 'Yagi array'. *[03]*

(d) An aerial is fed with a 12kw of power to produce the same field strength at a given point as a $\lambda/2$ dipole fed with 20kw of power. Calculate the gain of the aerial.

(i) relative to a $\lambda/2$ dipole
(ii) relative to an isotropic radiator

Assume the gain of a $\lambda/2$ dipole relative to an isotropic radiator is 2.15dB. *[06]*

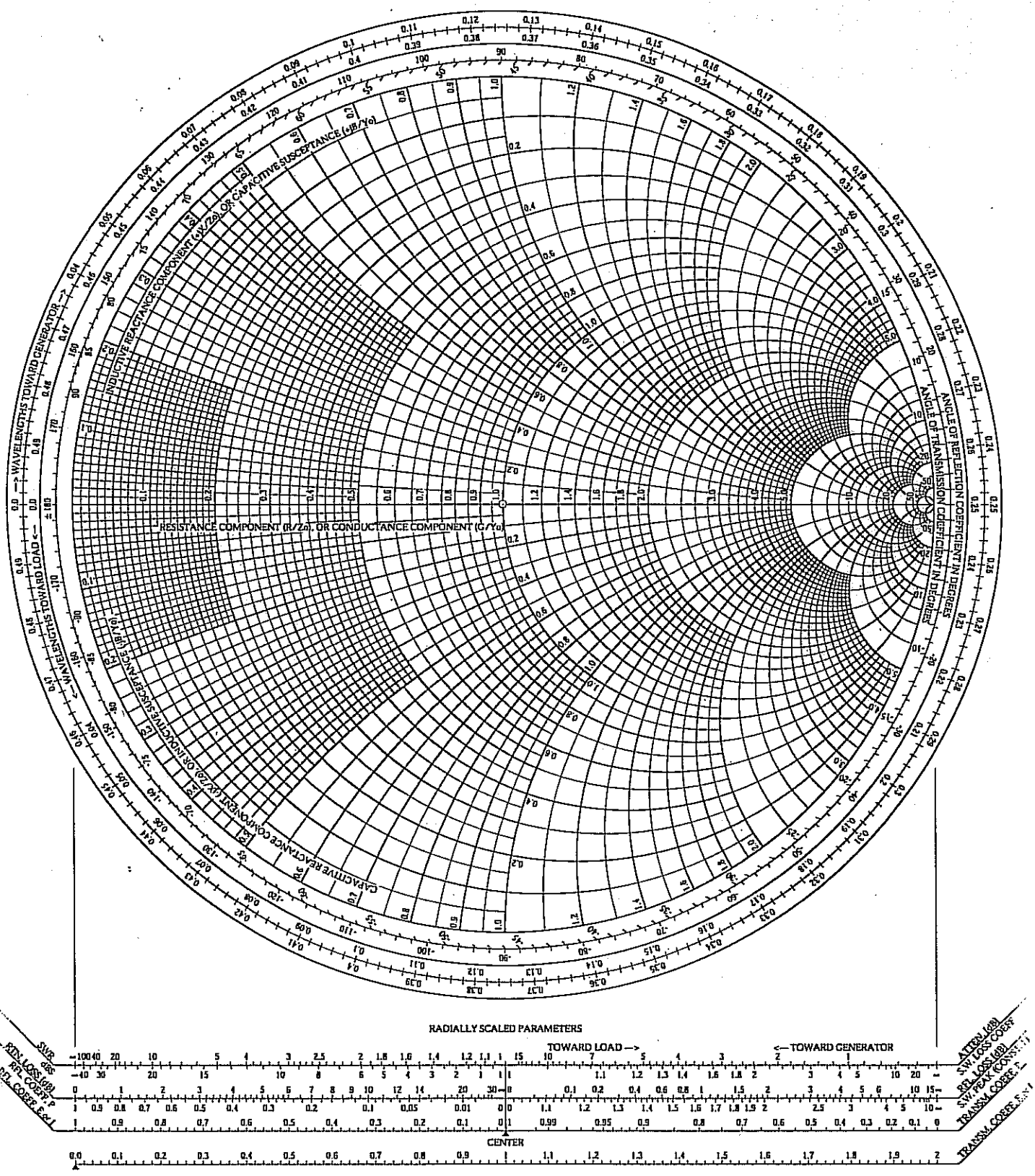
(e) Write short notes on the following related to cellular communication:

(i) Frequency reuse
(ii) Cell splitting
(iii) Cell sectoring *[03]*

Table 10.1 : Erlang loss formula table

Number of trunks	1 lost call in 50 (0.02)	100 (0.01)	200 (0.005)	1000 (0.001)	Number of trunks	1 lost call in 50 (0.02)	100 (0.01)	200 (0.005)	1000 (0.001)
	E	E	E	E		E	E	E	E
1	0.020	0.010	0.005	0.001	51	41.2	38.8	36.8	33.4
2	0.22	0.15	0.105	0.046	52	42.1	39.7	37.6	34.2
3	0.60	0.45	0.35	0.19	53	43.1	40.6	38.5	35.0
4	1.1	0.9	0.7	0.44	54	44.0	41.5	39.4	35.8
5	1.7	1.4	1.1	0.8	55	45.0	42.4	40.3	36.7
6	2.3	1.9	1.6	1.1	56	45.9	43.3	41.2	37.5
7	2.9	2.5	2.2	1.6	57	46.9	44.2	42.1	38.3
8	3.6	3.2	2.7	2.1	58	47.8	45.1	43.0	39.1
9	4.3	3.8	3.3	2.6	59	48.7	46.0	43.9	40.0
10	5.1	4.5	4.0	3.1	60	49.7	46.9	44.7	40.8
11	5.8	5.2	4.6	3.6	61	50.6	47.8	45.6	41.6
12	6.6	5.9	5.3	4.2	62	51.6	48.8	46.5	42.5
13	7.4	6.6	6.0	4.8	63	52.5	49.7	47.4	43.4
14	8.2	7.4	6.6	5.4	64	53.4	50.6	48.3	44.1
15	9.0	8.1	7.4	6.1	65	54.4	51.5	49.2	45.0
16	9.8	8.9	8.1	6.7	66	55.3	52.4	50.1	45.8
17	10.7	9.6	8.8	7.4	67	56.3	53.3	51.0	46.6
18	11.5	10.4	9.6	8.0	68	57.2	54.2	51.9	47.5
19	12.3	11.2	10.3	8.7	69	58.2	55.1	52.8	48.3
20	13.2	12.0	11.1	9.4	70	59.1	56.0	53.7	49.2
21	14.0	12.8	11.9	10.1	71	60.1	57.0	54.6	50.1
22	14.9	13.7	12.6	10.8	72	61.0	58.0	55.5	50.9
23	15.7	14.5	13.4	11.5	73	62.0	58.9	56.4	51.8
24	16.6	15.3	14.2	12.2	74	62.9	59.8	57.3	52.6
25	17.5	16.1	15.0	13.0	75	63.9	60.7	58.2	53.5
26	18.4	16.9	15.8	13.7	76	64.8	61.7	59.1	54.3
27	19.3	17.7	16.6	14.4	77	65.8	62.6	60.0	55.2
28	20.2	18.6	17.4	15.2	78	66.7	63.6	60.9	56.1
29	21.1	19.5	18.2	15.9	79	67.7	64.5	61.8	56.9
30	22.0	20.4	19.0	16.7	80	68.6	65.4	62.7	58.7
31	22.9	21.2	19.8	17.4	81	69.6	66.3	63.6	58.7
32	23.8	22.1	20.6	18.2	82	70.5	67.2	64.5	59.6
33	24.7	23.0	21.4	18.9	83	71.5	68.1	65.4	60.4
34	25.6	23.8	22.3	19.7	84	72.4	69.1	66.3	61.3
35	26.5	24.6	23.1	20.5	85	73.4	70.1	67.2	62.1
36	27.4	25.5	23.9	21.3	86	74.4	71.0	68.1	63.0
37	28.3	26.4	24.8	22.1	87	75.4	71.9	69.0	63.9
38	29.3	27.3	25.6	22.9	88	76.3	72.8	69.9	64.8
39	30.1	28.2	26.5	23.7	89	77.2	73.7	70.8	65.6
40	31.0	29.0	27.3	24.5	90	78.2	74.7	71.8	66.6
41	32.0	29.9	28.2	25.3	91	79.2	75.6	72.7	67.4
42	32.9	30.8	29.0	26.1	92	80.1	76.6	73.6	68.3
43	33.8	31.7	29.9	26.9	93	81.0	77.5	74.3	69.1
44	34.7	32.6	30.8	27.7	94	81.9	78.4	75.4	70.0
45	35.6	33.4	31.6	28.5	95	82.9	79.3	76.3	70.9
46	36.6	34.3	32.5	29.3	96	83.8	80.3	77.2	71.8
47	37.5	35.2	33.3	30.1	97	84.8	81.2	78.2	72.6
48	38.4	36.1	34.2	30.9	98	85.7	82.2	79.1	73.6
49	39.4	37.0	35.1	31.7	99	86.7	83.2	80.0	74.4
50	40.3	37.9	35.9	32.5	100	87.6	84.0	80.9	75.3

Smith Chart


RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
INDUCTIVE REACTANCE COMPONENT (+jX/Zo), OR CAPACITIVE SUSCEPTANCE (+jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo), OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
RADIALLY SCALED PARAMETERS
TOWARD LOAD —>
<— TOWARD GENERATOR
SWR
RTN. LOSS (dB)
REFL. COEFF. ρ
REFL. COEFF. ρ ∠
ATTEN. (dB)
S.W. LOSS COEFF.
REFL. LOSS (dB)
S.W. PEAK COEFF.
TRANSM. COEFF.
TRANSM. COEFF. ∠
CENTER