THE OPEN UNIVERSITY OF SRI LANKA

Department of Electrical and Computer Engineering
Final Examination 2014 /2015
Bachelor of Technology

ECX 4233 – COMMUNICATIONS

Closed Book Test

Date 03.09.2015. **Time: 09:30-12:30 hrs.**

INSTRUCTIONS TO CANDIDATES

1. This question paper contains **eight** questions in 7 pages. Page 8 contains Traffic table and Smith chart attached separately.
2. Answer any **Five** questions.
3. All the notations have their usual meaning.
4. Write your answer in short and point form.

Question 1

1. List down the factors should consider in telephone network planning. Discuss the importance of transmission and signalling limit in telephone network planning. .

(3 Marks)

2. Explain the basic differences between the local exchange and tandem exchange.

(2Marks)

3. ABC Telecommunication Company planning to expand their coverage area as shown in figure 1. Dashed lines show the virtual boundary of land segments. Concentrator ratio (ration between the number of subscribers and the number of cross points in an exchange - CR) and area is given in the diagram. The area beside the river is connected via radio link. Assume that subscribers are equally distributed in a given area and 20km radius area can be covered by an exchange.

   The company did a market research to identify the number of potential customers. It is decided to design the network considering future and current demand. Potential customer number is shown in the table 1.

Area	Area description	Number of Potential subscribers
A	Main City	320,000
B	Urban Area	200,000
D	Suburban	100,000
E	Suburban	100,000
F	Rural	30,000
G	Rural (Village)	6,000

Table 1

(a) Calculate required cross point for each area. Hence deduce required minimum number of E1 for city area (A).

(2 Marks)

(b) Assume that you have provided with any amount of electronic exchanges with following capacities.

Exchange type	No. Of cross points
EX1	45000
EX2	15000
RSU (Remote Subscriber Unite)	You can assume the capacity

(i) State any assumption you have made and design a hierarchical network structure indicating

- Type of exchange (Local, secondary, tandem etc.)
- Type of circuits between exchanges (trunk, junction)
- Signalling method between exchanges and local exchange and subscribers

(8 Marks)

(ii) Suggest a suitable numbering plan for your network structure.

(2 Marks)

(c) In modern telecommunication networks, there is a trend to way of hierarchical routing. State at least three reasons for that.

(3 Marks)

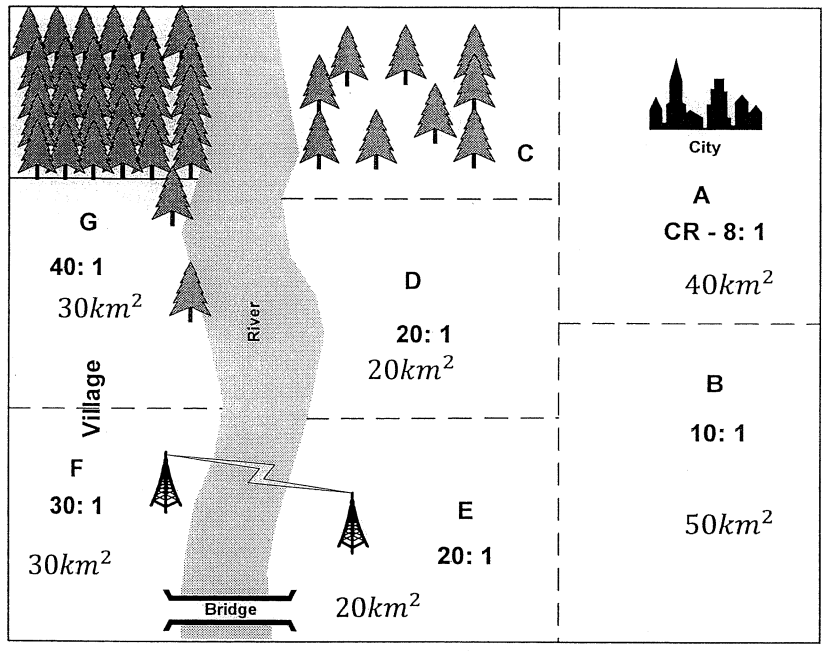

Figure 1

Question 2

1. Differentiate the following:
   (a) Space switch vs. Time switch
   (b) Single stage switching vs. Multiple stage switching
   (c) Wide sense of non blocking and Strict sense of non blocking

(6 Marks)

2. Fully interconnected three-stage switching network is shown in figure2. It has M incoming trunks and N outgoing trunks and has primary switches with n inlets and tertiary switches with n outlets.

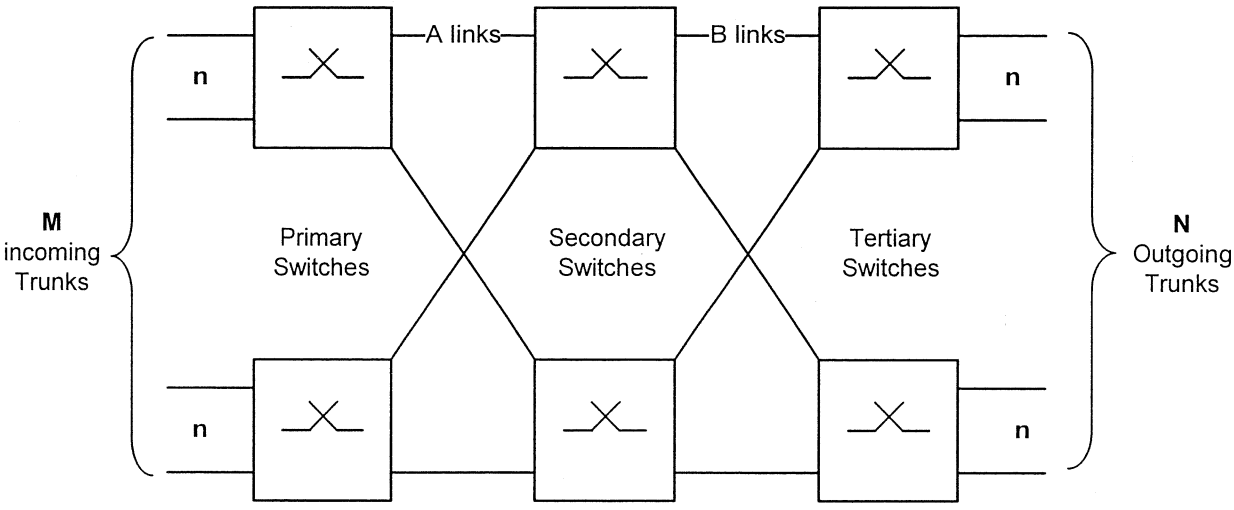

Figure 2

(a) If incoming and outgoing trunks equal to N,

(i) Find the Number of cross points in each stage

(ii) Show that the total number of cross points is given by N (2n+N/n)

(iii)Prove that the total number of cross point is a minimum when $n = \sqrt{N/2}$

(9 Marks)

(b) If the network acts as a concentrator (i.e M > N), Show that the minimum number of total cross points given is by$2N\sqrt{N+M}$. Hence deduce the same if the network is acting as an expander (i.e M < N)

(5 Marks)

Question 3

1. Sampled signal is shown in figure 3. The peak value of the signal is 2V. Giving reasons suggest a suitable quantization scheme.

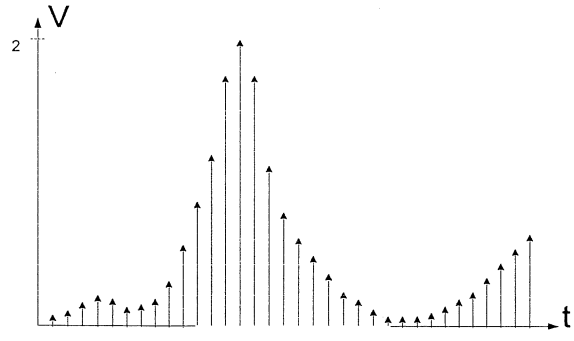

Figure 3

(3Marks)

2. Explain term "quantization distortion". If the system used linear quantization, explain how we can reduce the quantization distortion (error). Explain the downside of your action.

(4 Marks)

3. What is the key characteristic that makes the code words produced by PCM so well suited for use in Time Division Multiplexing (TDM) transmission?

(4 Marks)

4. Using a diagram as appropriate, explain what the difference is between Channel Associated Signalling and Common Channel Signalling. Why Common Channel Signalling was generally adopted throughout telecom systems?

(5 Marks)

5. The T1 System uses channel associated signalling, with 1 bit per channel for signalling data. What is the total bit rate a T1 system provides for signalling?

(4 Marks)

Question 4

1. Define grade of service. How can we improve the grade of service? Give the downside of this.

(2Marks)

2. Figure 4 shows the change of the traffic intensity in a one day. Give your suggestions to maximally utilize the network resources and generate more revenue.

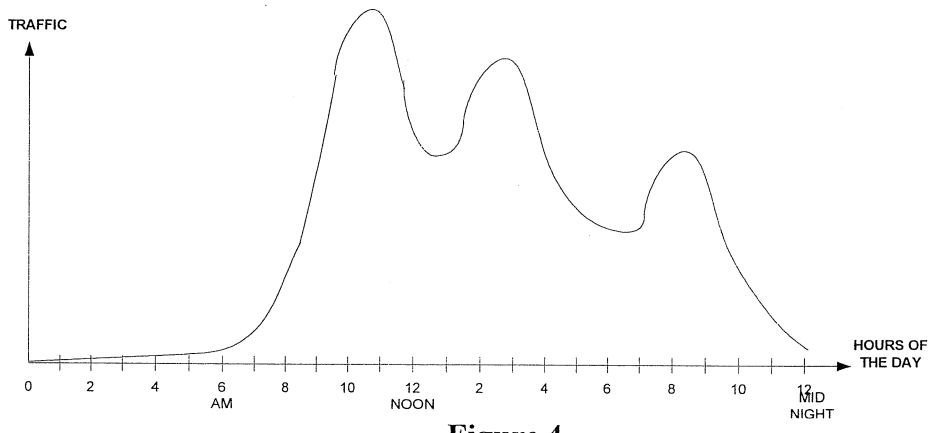

Figure 4

(2Marks)

3. In a particular exchange during busy hour 900 calls were offered to a group of trunks, during this time 6 calls were lost. The average call duration being 3 minutes. Calculate:
   (a) Traffic offered in Erlangs
   (b) Traffic lost
   (c) Grade of service
   (d) Period of congestion

(8Marks)

4. A group of 12 trunks is offered 4E of traffic. Find,
   (a) The Grade of Service
   (b) The probability that at least 3 trunks are free
   (c) If one trunk is out of service, what will be the Grade of Service?
   (d) If a 10% increase in the offered traffic in an emergency, what will be the Grade of Service?

(8Marks)

Question 5

1. A sensor unit (at A) and its receiver unit (B) are connected via 150m long coaxial unit. (Refer the figure 5) The sensor output is an analog signal and its frequency range is 1 kHz-1.8 kHz. Receiver unit captured the signal and converted to digital form. Receiver unit and server are connected via shielded twisted pair cables. Length between Receiver unit (at B) and the server (at C) is 10m.

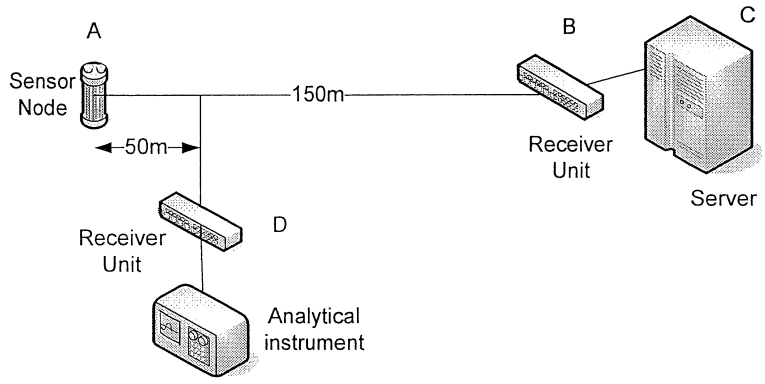

Figure: 5

(a) To test the system, a technician connects an identical receiver unit 50m from sensor node (at D). He argued it is enough to test the system from 50m.
Will he be able to capture data from the sensor node correctly? Give reasons for your answer.

(5Marks)

(b) In order to check the cable connectivity, square signal with 5 kHz frequency is transmitted in one end and received signal is observed using an oscilloscope from the other end. Transmitted and received signal is shown in figure 6.
Explain the reasons for signal deformation.

Figure 6

(3 Marks)

2.

(a) List five advantages of fibre optic lines over other transmission lines.

(4 Marks)

(b) Distance between sensor node and server shown in figure 5 is needed to be increased to 1km. It is decided to use fibre optic cable instead of coaxial cable. The receiver unit replaces with the optical fibre compatible unit. There are four connectors, two in sensor node side and two on the server side. Sensor side connector loss is 0.5dB and Transmitter side loss is 1dB. Cable loss is 1.5 dB/km. Sensitivity of the system is set to -20dB. If the system margin is 5dB,
Calculate the power of the light source that should connect to the fibre, in watts.

(8 Marks)

Question 6

1. Obtain an expression for the characteristic impedance, the propagation constant and attenuation constant for the following cases.
   (a) Ideal transmission line
   (b) High frequency transmission line

(4 Marks)

2. Sinusoidal voltage source transmission line and a load are connected as shown in figure 7. R is the source resistance.
   $v(t) = 10\sin(2\pi ft), R = 50\Omega, L = 0.25\mu H/m,\ C = 100pF/m, Length = 100m$

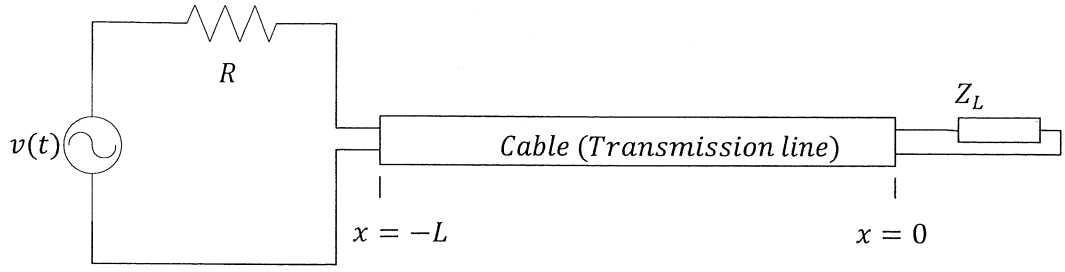

Figure 7

(a)
   (i) Determine the phase velocity of the wave.
   (ii) Find a value for Z_L So that there is no reflection in the line.
   (iii) Assume$Z_L = 150\Omega$, compute the fraction of the incident power that is reflected at the load.

(6 Marks)

(b) If the load is short circuited,
   (i) Find the lowest non zero frequency at which $Z_{in} = 0$.
   (Z_{in} *is the input impedance of the transmission line*)
   (ii) Find the lowest non-zero frequency at which the current flowing in the circuit is $i(t) = 0.2\sin(2\pi ft)\ A$.

(6 Marks)

(c) If $Z_L = 50 + 150j\ \Omega$, determine the reflection coefficient using a Smith chart.

(4 Marks)

Question 7

1.
   (a) What is co-channel interference in cellular networks

   (b) If we want to maximize the capacity of a cellular system explain what we should with the cell sizes. Are there any disadvantages with this action?

   (c) Explain what benefits gained to both customer and service providers by shift towards the use of IP-based packet switching. .

(2×3 Marks)

2. In a digital channelized cellular system, the bandwidth of the system is 12.5MHz. Eight users share each channel and three channels per cell are used for signalling. Other parameters, as given below.

   Channel spacing – 200 kHz, Area of a cell - $8km^2$, Total coverage area – 4000 km^2
   Frequency factor – 4, Average number of calls per user during the busy hour – 1.2
   Average holding time of a call – 100s, Call blocking probability – 2%

   Calculate the following parameters.
   (a) Total number of channels available in the system
   (b) Total traffic channels
   (c) Number of signalling channels per cell
   (d) Number of cells in the given area
   (e) Total traffic carried by the traffic channel per cell with 2% blocking probability
   Hint: Use Erlang B formula
   (f) Number of calls per hour per cell

(14 Marks)

Question 8

1.
   (a) A monopole antenna is placed in an electric field of 0.06V/cm. If the length is 1m; calculate the voltage induced in the antenna.
   (b) Sketch the polar diagrams of a half wave dipole antenna in the plane of the dipole and in a plane perpendicular of the dipole.
   (c) Explain the element arrangement in a Yaggi antenna.

(4 Marks)

2. For the bit stream 1001001110 sketches the waveforms for each of the following modulation schemes.
   (a) ASK
   (b) BFSK
   (c) BPSK

(6 Marks)

3. An analog signal carries 4 bits in each signal unit. If 1000 signal units are sent per second, find the baud rate and the bit rate.

(2 Marks)

4. Write shorts notes to following topics
   (a) Advantages of SDH system
   (b) Impotency of following telecommunication standards
   (c) OFDM spectral efficiency
   (d) Data rate of different LTE generations

(8 Marks)

END

Supplementary materials
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	46.8	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	59.5
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

The Complete Smith Chart