**THE OPEN UNIVERSITY OF SRI LANKA**
Department of Electrical and Computer Engineering
Final Examination 2013 /2014

## ECX 4233 – COMMUNICATIONS

**Closed Book Test**

**Time: 09:30-12:30 hrs.**                                    **Date 21.08.2014**

INSTRUCTIONS TO CANDIDATES

1. This question paper contains **Eight** questions. Answer any **Five** questions.
2. All the notations has it usual meaning.
3. Write you answer in short and point form.

## Question 1

1. Differentiate the following:
   i.   Local exchange area vs. multi exchange area
   ii.  Trunk exchange vs. tandem exchange
   iii. Pulse dialing vs. Tone dialing
   iv.  Transmission limit vs. Signaling limit

   **(4Marks)**

2. Draw a flow chart to illustrate all the sequence of operations, which take place during a successful telephone call between two subscribers in same local exchange.

   **(6 Marks)**

3. A small exchange "A" has a direct route to exchange "B" and another route to exchange "C", which carries traffic to all other destinations (Figure 1.1). The total traffic from A is 5E, of which 1E is to exchange B. The grade of service is required to be not worse than 0.01.
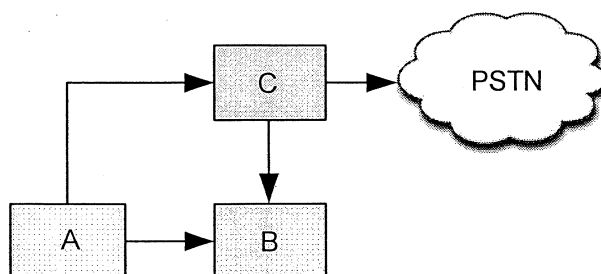


**Figure 1.1**

   Find the total number of outgoing trunks from A that is required if;
   i.   All traffic from A to B carried on the direct route.
   ii.  There are two trunks on the direct route and traffic overflows from these to the other route.
        (Refer traffic table attached)                              **(10 Marks)**

## Question 2

1. Differentiate the following:
   i. Space switch vs. Time switch
   ii. Single stage switching vs. multiple stage switching
   iii. CAS vs. CCS
   iv. PDH vs. SDH

   **(4Marks)**

2. A 2-stage space-division network acts as a concentrator, it has M incoming trunks, N outgoing trunks and N links between the two switching stages (where M>N). Two methods of designing the network are as follows:
   i. To use the same number of switches in each stage, but to have larger switches in the first stage.
   ii. To use switches in the primary stage which have the same number of inlets as the secondary switches have outlets, but to use different number of switches in each stage.

   Show the formation of each of the above switching network using diagrams. (You need to mark all the necessary parameters) Obtain expressions for the number of cross points at each case.

   **(10 Marks)**

3. Use your result in part (b) to design a network of each type for a 2-stage concentrator having 400 incoming trunks and 100 outgoing trunks. How many cross points does each contain?

   **(6 Marks)**

## Question 3

1. Briefly describe the following terms related to the telecommunication industry:
   i. Busy hour
   ii. Grade of Service
   iii. Traffic tables

   **(4Marks)**

2. During the busy hour, a telephone company establishes 150 outgoing calls of an average holding time of 2 minutes. It receives 220 incoming calls of average holding time of 3 minutes. The company expects to have a Grade of Service of 0.01 for both incoming and outgoing calls. Use the attached traffic table to answer the following.
   How many circuits should the company provide if:

   i. Incoming and outgoing calls are handled on separate group of lines.
   ii. A common group of lines is used for both incoming and outgoing calls.

   **(4Marks)**

3. In a full availability switching system, 12E of traffic is offered over a group of 4 trunks during the busy hour. Using Erlang's B formula find,
   - i. The probability that 3 trunks are occupied.
   - ii. The grade of service of the system.
   - iii. The probability that more than 2 trunks are free.

**(12Marks)**

## Question 4

1. A certain linear 8-bit sign- magnitude PCM code (The leftmost bit represents the sign bit, 1 = '+' and 0 = '-') has a resolution of 0.01V. Determine the quantization voltage levels correspond to the following codes.
   - i. 1 1 1 0 1 0 0 1
   - ii. 0 0 0 0 0 1 1 1
   - iii. 0 0 1 0 0 0 0 1

**(6Marks)**

2. E1 carrier systems were designed to combine PCM and TDM techniques for transmission 32 channels of 64kbps bandwidth with each channel cable of carrying digitally encoded voice band telephone signals of data. In an E1 frame format the first byte is used for frame alignment.
   - i. What is the standard bandwidth of input voice signals to the PCM?
   - ii. Hence find the sampling frequency to digitize the voice signals stated in (i). State a theorem that is used to find the sampling frequency.
   - iii. Show how the bandwidth becomes 64kpbs for one voice channel.
   - iv. Calculate bit rate of E1 carrier.

**(8Marks)**

3.
   - i. Draw and explain the frame structure of E1.
   - ii. Explain how 30 channels' signaling information is sent in an E1 frame.

**(6Marks)**

## Question 5

1. A generator of 10V at 1 kHz supplies power to a 100km open wire line terminated with its characteristic impedance. The primary line constants are:

   $R = 10.4\Omega/km$, $L = 0.0036H/km$, $G = 0.8 \times 10^{-6} mho/km$ and $C = 0.00835\mu F/km$.

   Calculate,
   - i. Characteristic impedance.
   - ii. Propagation constant.
   - iii. Velocity of propagation.
   - iv. Wavelength of propagation.
   - v. The amount of power delivered to the load.

**(10 Marks)**

2. A transmission line which has a characteristic impedance of 50 Ω ends up with a load impedance of $(150 - j100)$ Ω. If the electrical length of the line is $0.2\lambda$, find the following using Smith Chart (attached).
    i. The voltage reflection coefficient.
    ii. Input impedance of the line.

**( 6 Marks)**

3. A surveillance camera is located 150m away from its main control room. It is connected via coaxial cable. It is found that the camera is not working due to cable damage and it is physically not visible. It is needed to locate damaged position.

Using your knowledge in transmission lines, suggest suitable methodology to locate the faulty position. Briefly, but clearly state all the steps and the assumption you have made.

**( 4 Marks)**

## Question 6

1. Briefly explain how standing waves are formed in transmission lines.

**( 4 Marks)**

2. Draw the standing wave patterns for the following load conditions. Explain each situation.
    i. Load impedance = 0
    ii. Load impedance = infinity
    iii. Load impedance = characteristic impedance

**( 6 Marks)**

3. The voltage set up on a lossless transmission line at a distance "x" from the source end could be expressed as

$$v = V^+ e^{-j\beta x} + V^- e^{+j\beta x}$$

    i. Using the quantities given in the above equation, write an expression for the reflection coefficient at a distance "x".
    ii. Hence, prove that magnitude of the reflection coefficient remains constant along the line.
    iii. Deduce that no reflections are possible on a matched line.
    iv. If $V^+ = 0.5mV$ and $V^- = 0.4mV$, find the maximum and minimum voltages set up on the line.
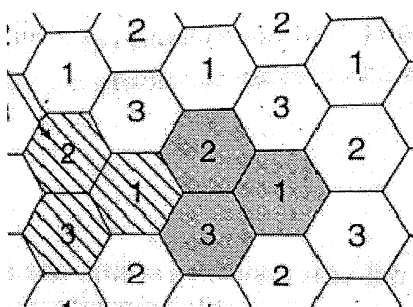    v. Calculate VSWR set up on the line.
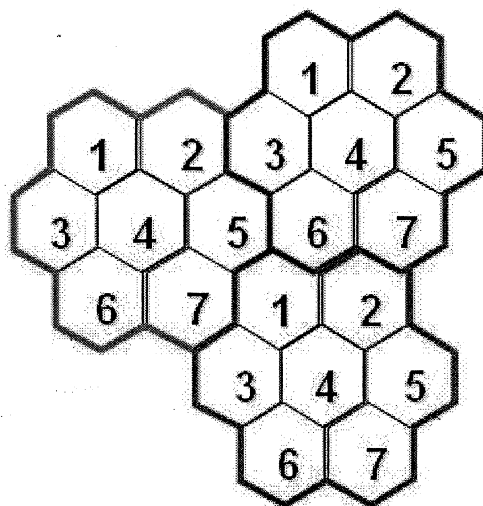
**( 6 Marks)**

## Question 7

1. Write short notes on following topics.
    i. WiMAX
    ii. LTE
    iii. CDMA
    iv. OFDM

**( 8 Marks)**

2. Consider two channel reuse arrangements given in figures 7.1 and 7.2.

    i. Calculate the reuse distance for arrangements shown in figures 7.1 and 7.2 in terms of the hexagonal cell radius R.

    ii. Considering a given area and given cell radius, which of these two arrangements would produce a higher overall channel capacity? With mathematical equations, justify your answer.

    iii. One argued that none of arrangements (Figures 7.1 and 7.2) is suitable for both urban and rural and proposed the arrangement shown in figure 7.3.

      Technically evaluate the above statement. **(4 Marks)**



N = 3
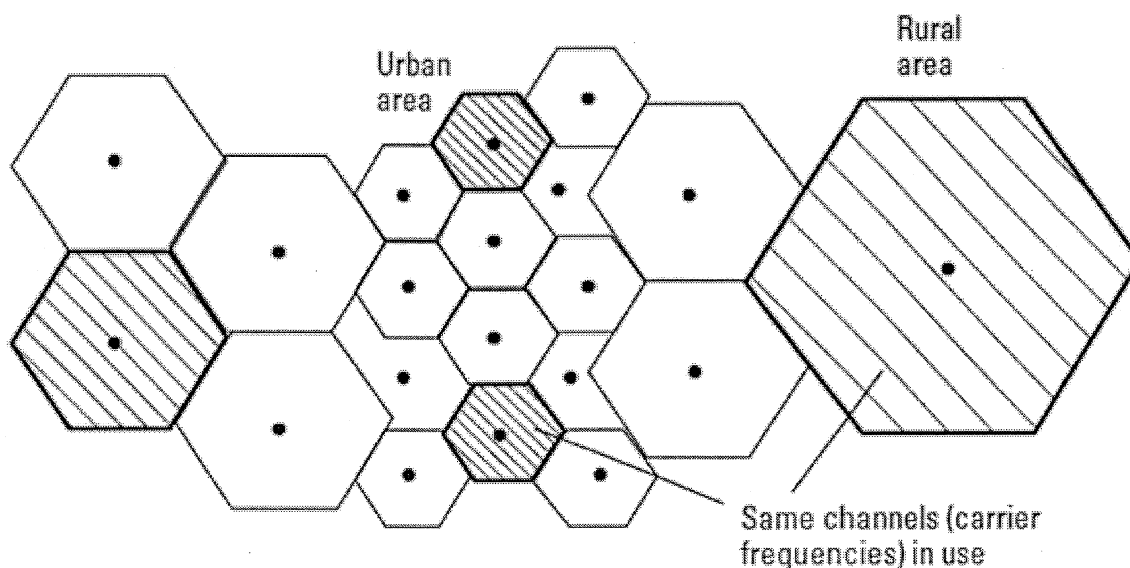
Figure 7.1

N = 7

Figure 7.2



Urban area

Rural area

Same channels (carrier frequencies) in use

Figure 7.3

3. "VoIP is the future of telecommunication". Critically evaluate the above statement.

**( 4 Marks)**

## Question 8

1. Briefly explain the following terms related to antennas.
   i. Directivity
   ii. Beam width
   iii. Radiation pattern
   iv. Polarization mismatch

( 4 Marks)

2. Sketch the current and voltage distributions for the following.
   i. A single-wavelength long centre-fed dipole
   ii. A half-wave centre-fed dipole
   iii. A two-wavelengths long centre-fed dipole

( 3 Marks)

3. Define the term radiation resistance of an antenna. Explain its practical significance as a property of transmitting and receiving antenna.

( 3 Marks)

4. The radiated power of a low frequency transmitting antenna is 500W. If the radiation resistance and the loss resistance of the antenna are $2\,\Omega$ and $0.1\,\Omega$ respectively, Find,
   i. The current fed into the antenna
   ii. The input power
   iii. The efficiency of the antenna

( 10 Marks)

**END**

**Traffic table**

| Number of trunks | 50 (0.02) | 100 (0.01) | 200 (0.005) | 1000 (0.001) | Number of trunks | 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 | 47.9 | 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 | 73.5 |
| 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 |

RADIALLY SCALED PARAMETERS