00137

THE OPEN UNIVERSITY OF SRI LANKA

Department of Electrical and Computer Engineering
Final Examination 2015 /2016
Diploma in Engineering Technology

ECX 4233 – COMMUNICATIONS

Closed Book Test

Date 02.12.2016. **Time: 09:30-12:30 hrs.**

INSTRUCTIONS TO CANDIDATES

1. This question paper contains **eight** questions in 7 pages.
2. Answer any **five** questions.
3. All the notations have its usual meaning.
4. Write your answer in short and point form.

Question 1

1. State two advantages of having Hierarchical structure for PSTN networks.

(2 Marks)

2. Explain the three differences between the local exchange and RSU.

(3Marks)

3. Imagine, the government has decided to build a technical city using land available in a rural area. The first stage will complete by two years and estimated time for the entire project is 5years. The area is divided into five $10km^2$ segments. At the moment there is no wired network in the area. It is projected after two years, each state will have 5,000 subscribers and it will increase by 15% each year till end of 5 years.

   Suggest PSTN hierarchical structures for voice calls and number planning for the same. State any assumption you have made.

(9Marks)

4. State there signaling points in the SS7 and explain function of each point.

(6Marks)

Question 2

1. Compare the **transfer time** of circuit switching, packet switching and message switching. Explain two drawbacks of message switching over packet switching.

(3Marks)

2. In what sense a multiple-stage switch is better than a single-stage switch? What are the disadvantages of a multiple-stage switch when compared with a single-stage switch?

(3Marks)

3. A 50-input, 50-output 3-stage strict sense non-blocking switching network has to be designed according to Figure Q2.
   (i) Calculate the number of middle stage switches required.
   (ii) To obtain the near minimum cross points, prove that n = 5.
   (iii) Compare the number of cross points in (ii) above with the number of cross points in a 50-input, 50-output 2-stage switch with n = 5. Comment on your answer.

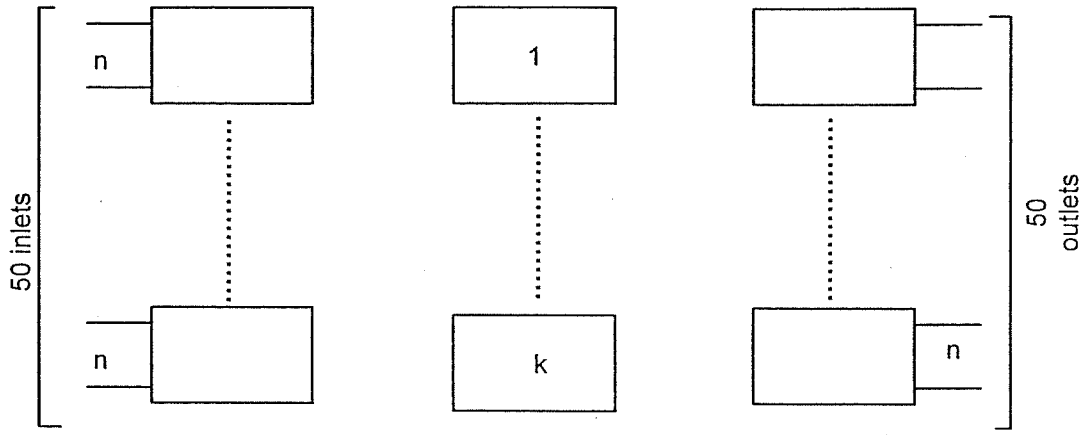

Figure Q2

(10 Marks)

4. List down four factors you should consider in telephone network planning.

(4 Marks)

Question 3

1. Consider a digital communication system where an analogue signal with a bandwidth of W Hz is sampled and converted into pulse code modulation (PCM) words. Each PCM word has m bits. V_{pp} is the peak to peak voltage of the analog signal. L is the number of quantization levels. Further, Δ and e to denote the uniform interval (gap) between two adjacent quantization levels and quantization error respectively. The system is designed such that the maximum quantization error will not exceed a fraction, p, of the peak-to-peak voltage.
   (i) Express the number of quantization levels, L, in terms of m.
   (ii) Express the maximum quantization error (maximum value of e) in term of, Δ.
   (iii) Derive the number of bits per PCM word, m, in terms of p.
   (iv) What is the minimum transmission rate such that the signal can be recovered at the receiving end? Express it in term of p and W

(6 Marks)

2. In a data logging application, it is required to store analog signal sent by a sensor node. It is designed to store the data by sampling and storing the sample values. The frequency of the signal is 9.6 kHz. In the first attempt, samples are quantized in to 32 level and later it is changed to 64 levels. Calculate the additionally required memory space to store 5minute of data.

(4 Marks)

3. Suppose an organization leases a T-1 line between the two sites. Suppose that 32 kbps speech coding is used instead of PCM. Explain how the T-1 line can be used to carry twice the number of calls.

(4 Marks)

4. A Digital E1 carrier frame uses 8-bit time slots and repeats at every 125 μsec.
   (i) Draw the frame structure of E1 digital carrier.
   (ii) Calculate the size of a single frame in bits.
   (iii)Calculate the bit rate of E1 carrier

(6 Marks)

Question 4

1. Discuss the status of a telephone exchange for the following two cases:
   (i) When Grade of Service = 1
   (ii) When Grade of Service = 0

(2Marks)

2. Starting from the Erlangs' first formula, derive the following equation.

$$V(n+1) = 1 + \frac{(n+1)V(n)}{A}$$

Where, $V(n) = \frac{1}{B(n)}$ *and* $V(n+1) = \frac{1}{B(n+1)}$

Hint: Write the Erlang B formula for a congestion of B (n) for n trunks and offered traffic of A Erlangs. Find B (n+1) (i.e. the congestion for (n+1) number of trunks) and divide B (n+1) by B (n).

(10Marks)

3. During the busy hour a switching system receives 100 calls with an average call duration Of 3 minutes. If the system is consisted of 10 trunks,

   (i) Find the GOS.
   (ii) If one trunk is added calculate the new GOS using equation derived from Q4 (2).
   (iii)Hence, calculate the percentage of improvement of GOS.

(8Marks)

Question 5

1. Draw a block diagram of a typical fiber optical communication system and briefly explain the function of all blocks.

(5Marks)

2. Compare single and Multimode fibers on Primary attenuation, Bandwidth and Signal quality.

(3 Marks)

3. A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47 Determine:

   (i) The critical angle at the core, cladding interface
   (ii) The NA (Numerical Aperture) for the fiber
   (iii)The acceptance angle in air to the fiber

(4Marks)

4. It is required to connect two buildings with a fiber optic link. Cable length is 1km. There are four connectors, two in transmitter side and two on the receiver side. Receiver side connector loss is 1dB and Transmitter side loss is 1.5dB. Cable loss is 2dB/km. Sensitivity of the system is set to -30dB. If the system margin is 5dB, calculate the power of the light source that should connect to the fiber in watts.

(8 Marks)

Question 6

1. Show that the phase constant is linearly dependent on frequency while the attenuation constant is frequency independent for a lossless line.

(3 Marks)

2. A signal generator of impedance 600Ω and e.m.f. 5V at 796Hz supplies power to a 200km open wire transmission line terminated by an impedance of $300\angle 45^0\Omega$. The primary line constants are $R = 10.4\Omega/km$, $L = 0.00367H/km$, $G = 0.8\times10^{-6} mho/km$ and $C = 0.00835\mu F/km$. Calculate,

   (i) Characteristic impedance
   (ii) Propagation constant
   (iii)Velocity of propagation
   (iv)Wavelength of propagation
   (v) Receiving end voltage
   (vi)The amount of power delivered to the load.

(10 Marks)

3. Make a rough sketch of an impedance Smith chart, with circle r = 0.,1,2 and x = -2, -1, -0.5, 0.5, 1, 2 and make the open end point, short end point and perfectly matched point of the load on it.

(4 Marks)

4. Explain how you smith chart to find the VSWR of particular load point. (You can use sketched smith chart in (3))

(3 Marks)

Question 7

1. Draw a labeled block diagram of a typical mobile network, including the following components.
   - Mobile Station (MS).
   - Base Station Controller (BSC).
   - Home Location Register (HLR).
   - Authentication Centre (AUC).
   - Base Transceiver Station (BTS).
   - Mobile Switching Centre (MSC).
   - Visitor Location Register (VLR).
   - Equipment identity Register (EIR).

(4 Marks)

2. Describe the roles of the VLR and HLR. Why are these essential to the operation of the network?

(4 Marks)

3. A full duplex cellular system, total spectrum is 30 MHz is allocated. Each simplex channel has 10 kHz bandwidth. The network consists with 280 cells with each hexagonal cell area of$1.8km^2$. Four uses share each channel and two channels per cell are used for control channels. Find,
   (i) The number of duplex channels.
   (ii) Total channel capacity if m = 4 and m =7, where m denotes the frequency reuse factor. Comment on the results you have obtained.
   (iii) Total number of channels per cell. Traffic channels per cell.
   (iv)If cell size is increased to $3.6km^2$, what will be the effect to the total channel capacity calculated in (iii)

(12 Marks)

Question 8

1. Briefly explain the following terms related to the effectiveness of an antenna.
   (i) Beam area
   (ii) Beam efficiency
   (iii)Effective aperture
   (iv)Directivity

(4 Marks)

2. An aerial is fed with 12kW of power to produce the same strength at a given point as a half wave dipole fed with 24kW of power. Assume the gain of a half wave dipole relative to an isotropic radiator is 2.15dB. Calculate the gain of the aerial,
   (i) Relative to a half wave dipole
   (ii) Relative to an isotropic radiator

(4 Marks)

3. Explain the QPSK modulation scheme. (Use appropriate diagram if necessary)
   A message signal representing the sequence of data D = 1 0 1 1 0 0 0 1 is to be transmitted using QPSK scheme. Draw the modulated signal.

(4 Marks)

4. Write shorts notes to following topics
   (i) 2W/4W and 4W/2W Conversion
   (ii) Call Handoff and Roaming
   (iii) OFDM
   (iv) Optical transport network

(8 Marks)

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Supplementary materials

Erlang's B Formula

$$P(N,A) = B = \frac{\frac{A^N}{N!}}{1+\frac{A}{1!}+\frac{A^2}{2!}+\frac{A^3}{3!}+.....+\frac{A^N}{N!}} = \frac{\frac{A^N}{N!}}{\sum_{X=0}^{X=N}\frac{A^X}{X!}}$$

Where:

A = Average offered traffic
N = No of outlets (circuits)
r = No of simultaneously occupied outlets or circuits

Traffic capacity table for full-availability groups is given in the next page

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	59.6
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