UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: July 2016

Module Number: EE7210 **Module Name: Telecommunication Networks**

[Three Hours]

[Answer **all questions**, each question carries **12.5 marks**]

Q1 a) i) What are the key characteristics of Next Generation Networks (NGNs)?

ii) Briefly explain the functions of different layers in NGN architecture.

iii) Compare and contrast Common Channel Signaling with Channel Associated Signaling.

[6.0 Marks]

b) Passive Optical Network (PON) based Fiber-To-The-Home (FTTH) solutions are becoming more and more popular these days due to the growing bandwidth requirements of customers.

i) What is meant by a Passive Optical Network?

ii) What are the advantages of FTTH over copper loop based ADSL (Asymmetric Digital Subscriber Line)?

iii) Draw a simple diagram to illustrate the main components in PON based FTTH technology and identify the main components.

iv) A particular FTTH customer is located 2 km away from the secondary splitter and the distance between primary and secondary splitters is 6 km. the primary splitter has 1 : 8 splitting levels and the secondary splitter has 1 : 4 splitting levels. If the Optical Line Terminal (OLT) is located 1.5 km away from the primary splitter, determine the optical power loss from OLT to the customer premises. The splitter loss is $3.5 \times N$ dB for 2^N splitter and the fiber attenuation loss is 0.35 dB/km.

[6.5 Marks]

Q2 a) A WCDMA user belongs to a Sri Lankan Network roams in India. He is currently served by an Indian Network and wants to initiate a data session.

i) Draw a simple diagram to show the main interfaces of WCDMA PS (Packet Switch) core Network Architecture.

ii) What is meant by GPRS Roaming Exchange (GRX)?

iii) Draw a diagram to show the GRX, Home and Visiting Network components for serving that particular data session. Indicate the traffic path between nodes clearly.

[6.0 Marks]

b) i) Draw a diagram to illustrate main components in LTE Network Architecture and briefly explain the functions of each node.

ii) What is meant by Service Architecture Evolution (SAE) in LTE? State the advantages of SAE compared to WCDMA Core Network?

iii) A 10 MHz FDD (Frequency Division Duplex) LTE system uses 10% of total bandwidth for the guard band and 15 kHz sub carrier spacing. The system operates at a normal CP (Cyclic Prefix) with seven OFDM symbols per 0.5 ms time slot. Determine the followings.

I. Number of sub carriers

II. Number of resource blocks and resource elements.

III. The peak download speed for category 4 user equipment assuming 64 QAM (Quadrature Amplitude Modulation)

[6.5 Marks]

Q3 (a) i) Describe the operation of a Step-by-Step Switch using a suitable diagram.

ii) What are the main disadvantages of a Step-by-Step Switch?

iii) Design a 2-stage 100 line non-blocking switching system with uni-selectors. Determine the following parameters of the system.

I. Switching Capacity

II. Equipment Utilization Factor

III. Cost Capacity Index (Assume cost per uni-selector is 1 unit)

[6.0 Marks]

(b) i) Write down the advantages and disadvantages of following capital budgeting techniques.

I. Accounting Rate of Return (ARR)

II. Payback Period Method

III. Net Present Value (NPV) and Internal Rate of Return (IRR)

ii) A firm plans to invest for a project with following cash flows.

Year	1	2	3	4	5	6	7	8
Net cash flow (Rs)	2,000	3,000	4,000	3,500	3,000	2,000	1,000	1,000

The project requires an initial investment of Rs 12,500 and the firm expects a rate of return of 10 percent. Calculate the payback, the discounted payback and the net present value to determine whether the project should be accepted or not.

[6.5 Marks]

Q4 (a) i) Define following terms.

I. Call Holding Time

II. Busy Hour

III. Grade of Service (GoS)

ii) During the busy hour a group of trunks is offered 120 calls having an average duration of 3 minutes. However, 3 calls fail to find a disengaged trunk.

I. What is the Grade of Service?

II. Determine the carried traffic in Erlangs.

III. If the traffic arrival follows a Poisson distribution, what is the probability that more than 2 calls are received at a monitoring period of 1 minute?

[6.0 Marks]

(b) The blocking probability of an N-trunk system with an offered load A is

$$E_{1,N}(A) = \frac{\frac{A^N}{N!}}{\sum_{k=0}^{N} \frac{A^k}{k!}}$$

i) State the assumptions required to prove that the above equation is true.

ii) Using the above equation, show that

$$E_{1,N}(A) = \frac{AE_{1,N-1}(A)}{N + AE_{1,N-1}(A)}$$

Hint: $AE_{1,N-1}(A)$ is the blocking probability of a system with $(N-1)$ trunks and offered traffic A.

iii) A group of 20 trunks provides a Grade of Service of 0.01 when offered 12E traffic. Determine the new GoS values,

I. if one trunk is Out-of-Service.

II. if one more link is added.

[6.5 Marks]

PRESENT VALUE TABLE

Present value of \$1, that is $(1+r)^{-n}$ where r = interest rate; n = number of periods until payment or receipt.

Periods (n)	Interest rates (r)									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621
6	0.942	0.888	0.837	0.790	0.746	0705	0.666	0.630	0.596	0.564
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149

Periods (n)	Interest rates (r)									
	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833
2	0.812	0.797	0.783	0.769	0.756	0.743	0.731	0.718	0.706	0.694
3	0.731	0.712	0.693	0.675	0.658	0.641	0.624	0.609	0.593	0.579
4	0.659	0.636	0.613	0.592	0.572	0.552	0.534	0.516	0.499	0.482
5	0.593	0.567	0.543	0.519	0.497	0.476	0.456	0.437	0.419	0.402
6	0.535	0.507	0.480	0.456	0.432	0.410	0.390	0.370	0.352	0.335
7	0.482	0.452	0.425	0.400	0.376	0.354	0.333	0.314	0.296	0.279
8	0.434	0.404	0.376	0.351	0.327	0.305	0.285	0.266	0.249	0.233
9	0.391	0.361	0.333	0.308	0.284	0.263	0.243	0.225	0.209	0.194
10	0.352	0.322	0.295	0.270	0.247	0.227	0.208	0.191	0.176	0.162
11	0.317	0.287	0.261	0.237	0.215	0.195	0.178	0.162	0.148	0.135
12	0.286	0.257	0.231	0.208	0.187	0.168	0.152	0.137	0.124	0.112
13	0.258	0.229	0.204	0.182	0.163	0.145	0.130	0.116	0.104	0.093
14	0.232	0.205	0.181	0.160	0.141	0.125	0.111	0.099	0.088	0.078
15	0.209	0.183	0.160	0.140	0.123	0.108	0.095	0.084	0.079	0.065
16	0.188	0.163	0.141	0.123	0.107	0.093	0.081	0.071	0.062	0.054
17	0.170	0.146	0.125	0.108	0.093	0.080	0.069	0.060	0.052	0.045
18	0.153	0.130	0.111	0.095	0.081	0.069	0.059	0.051	0.044	0.038
19	0.138	0.116	0.098	0.083	0.070	0.060	0.051	0.043	0.037	0.031
20	0.124	0.104	0.087	0.073	0.061	0.051	0.043	0.037	0.031	0.026

Q3 a) Consider the following periodic signal

$$\tilde{x}[n] = 1 + \sin\left(\frac{2\pi n}{10}\right)$$

Determine the period of $\tilde{x}[n]$.

[2 Marks]

b) i) Determine the Fourier transform of the following discrete-time signal.

$$x[n] = \begin{cases} e^{j\omega_0 n} & 0 \le n \le (N-1) \\ 0 & \text{otherwise} \end{cases}$$

ii) Is there any relationship between the N-point DFT (Discrete Fourier Transform) of $x[n]$ and the Fourier transform of $x[n]$ obtained in part i)?

[3 Marks]

c) Consider a real valued finite length discrete-time sequence

$$x[n] = \left[1,\ 2,\ \underset{\uparrow}{3},\ 2,\ 1,\ 0\right]$$

Determine the finite length sequence y[n] whose 3-point DFT is

$$Y[k] = X[2k] \qquad k = 0,1,2$$

where $X[k]$ is the 6-point DFT of $x[n]$.

[5 Marks]

Q4 a) Compute the 4-point DFT of the sequence

$$x[n] = \cos\left(\frac{n\pi}{2}\right)$$

using the decimation-in-time Fast Fourier Transform (FFT) algorithm.

Note: Show all the computations made at each intermediary stage.

[5 Marks]

b) Compute the 4-point DFT for the same sequence in part a) using the DFT mathematical expression.

Note: Compare the DFT coefficients obtained in part a) and b).

[3 Marks]

c) Compare the computational complexity in terms of the number of real additions and multiplications required for part b) and c).

[2 Marks]