



## UNIVERSITY OF RUHUNA

### Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2021

**Module Number: EE7210**

**Module Name: Telecommunication Networks**

**[Three Hours]**

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

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- Q1 a) Briefly explain the following
- Local loop
  - Plesiochronous Digital Hierarchy (PDH)
- [2 Marks]
- b) Briefly explain how the DS0 channel rate becomes 64 kbps. Use calculations when necessary.
- [1 Mark]
- c) Suppose that a 4G mobile SIM card which is in working condition is inserted to a 4G broadband router and identified that the broadband router is not providing the service. Using the operating principles in 4G and access networks, briefly explain the cause of this problem.
- [2 Marks]
- d) i) Estimate the efficiency of E4 and J4 lines.  
ii) Suppose that there is an opportunity to invest in a Public Switched Telephone Network (PSTN) which consists of E2 and J2 lines. The network provides two options, either to multiplex from E2 to E4 or from J2 to J4. Choose the more efficient option out of the two in terms of data rates. Show all the calculation steps.  
iii) Suppose that a number of ISDN Primary Rate Interface (PRI) channels are multiplexed to one T2 Line. Calculate the efficiency of the ISDN transmission in terms of effective data rate. Compare the result with the effective data rate when multiplexed to an with E2 Line.  
Note: Refer to Table Q1.1 and Table Q1.2 for additional information.
- [7.5 Marks]
- Q2 a) i) Briefly explain what is meant by the memory less property of Markovian inter-arrival time.  
ii) Briefly explain what is meant by traffic volume in terms of number of call arrivals and mean call duration.  
iii) Determine the traffic volume in a system in terms of Centum Call Seconds (CCS) if the system experiences 500 calls with each call having a mean duration of 45 seconds.
- [3 Marks]

b) Consider a local exchange in which the call inter-arrival times and the service time are exponentially distributed. Suppose that the exchange consists of  $N$  outgoing trunks with no queues.

- i) Derive an expression for the probability that all  $N$  trunks are occupied. Note that the mean call arrival rate is  $\lambda$  and the mean call duration is  $1/\mu$ .
- ii) Calculate the carried traffic by the fourth server, if sequential channel assignment is used and the offered traffic intensity is 2 Erlang.

[4 Marks]

c) i) Give one relationship between the average number of users in the system, mean duration that a user spends in the system and the mean call arrival rate of the system.

- ii) Consider a single server system with an infinite queue length. Evaluate the mean number of users in the system when the probability of the system being idle is 0.2.

[Hint: Use appropriate equations provided with Figure Q2 and find the traffic intensity]

- iii) Calculate the mean waiting time of the system given that the mean call duration is 30 seconds.

[5.5 Marks]

$$P_0 = \frac{(1 - \rho)}{(1 - \rho^{K+1})}$$

$$P_0 = (1 - \rho)$$

$$P_0 = \frac{1}{\left(1 + \frac{(C\rho)^C}{C!(1-\rho)} + \sum_{n=1}^{C-1} \frac{(C\rho)^n}{n!}\right)}$$

$$N = \frac{\rho}{(1 - \rho)} - \frac{(K + 1)\rho^{K+1}}{(1 - \rho^{K+1})}$$

$$N = \frac{\rho}{(1 - \rho)}$$

$$N = C\rho + B \frac{\rho}{(1 - \rho)}$$

Figure Q2



- Q3 a) i) List two types of electromechanical switches  
 ii) Using an illustration, briefly explain how a step-by-step switch would work when dialing the number 87436. [3.5 Marks]
- b) i) Briefly explain what is a blocking space switch and a non-blocking space switch.  
 ii) How many cross points are required for a single stage non-blocking space switch with 20 users in the system?  
 iii) State two advantages of multi-stage space switch over a single-stage space switch. [4 Marks]
- c) i) What is meant by the Stored Program Control related to space or time switches?  
 ii) Describe the Synchronous Duplex Mode? [2 Marks]
- d) i) Briefly explain how a time-slot interchange switch works.  
 ii) Briefly explain what a T-S-T is and state its advantage over a S-T-S switch. [3 Marks]

- Q4 a) i) List the network component that provides the radio access to the user equipment in 3G, 4G and 5G networks, respectively.  
 ii) Briefly explain the functionality of an Home Location Register (HLR).  
 iii) In Universal Mobile Telecommunication Service (UMTS), the user equipment is said to have multi radio access technology (multi RAT). Briefly explain the multi RAT in UMTS. [3.5 Marks]
- b) i) Compare the difference between security and privacy in a mobile network.  
 ii) What is meant by authentication with respect to a telecommunication network?  
 iii) Explain the authentication process used in GSM networks. [6 Marks]
- c) i) A 5G mobile core network in one small room in an office. Briefly explain the reason for this being possible.  
 ii) Suppose that you are using a number of different applications over the internet in a 5G network. Identify how this is made possible in 5G networks.  
 iii) Briefly explain a mechanism that can be applied in mobile networks to reduce the False Base Station Attacks. [3 Marks]

Table Q1.1

Digital Mux Level	# of 64Kbps Channels	North American Standard T (Mbps)	European Standard E (Mbps)	Japanese Standard J (Mbps)
0	1	0.064	0.064	0.064
1	24	1.544		1.544
	30		2.048	
	48	3.152		3.152
2	96	6.312		6.312
	120		8.448	
3	480		34.368	32.064
	672	44.376		
	1344	91.053		
	1440			97.728
4	1920		139.264	
	4032	274.176		
	5760			297.200

Table Q1.2

PRI - North American standard
23 - B channels (DS0) 1 - D channel (DS0)
PRI - European standard
30 - B channels (DS0) 1 - D channel (DS0)