BITS Pilani Dubai Campus, International Academic City, Dubai, U.A.E.

II Semester, Academic Year 2010-11, III Year B.E. (Hons.) ECE

COMPREHENSIVE (Closed Book)

ECE C394 COMMUNICATION NETWORKS

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Date: 26th May, 2011 **Max. Marks: 80**

Duration: 3 Hours **Weightage: 40%**

Note:- 1.**Answer** ALL the Questions of Part-A and Part-B **in two separate Answer Booklets**

PART-A

1 Assume that a certain system is designed with FDDI. FDDI operates at 100 Mbps in a ring that spans up to 200 Km and accommodates up to 500 stations. Assume each station introduces a latency of 10 bits. It is also given that signals travel at 2 x 10^8 m/sec in the fiber optic cable. It is given that the largest FDDI frame is 4500 bytes. **(13M)**

A Determine the ring latency in seconds assuming the information given in question 2

B What is the efficiency of the protocol given the FDDI frame structure above? Assume that the definition of efficiency, $\eta_{overhead}$ = (number of information bits)/(total number of bits). 2

C Justify why for the FDDI specifications given above, FDDI should be considered as a multi-token ring system rather than a one frame per token and single-frame operation ring system. 3

D Assuming a multi-token ring, calculate the following:

(i) Maximum normalized throughput. 2

(ii) Mean waiting time in seconds for the calculated maximum throughput in part (i). 2

E How would you transmit 6000 information bytes? 2

Assume an IPv6 header of 40 bytes, TCP header of 20 bytes, and a UDP header of 8 bytes. Calculate the efficiency of the protocol if **(4M)**

F TCP/IP is used on top of FDDI (FDDI is layer 1 and layer 2 of OSI stack) 2

G UDP/IP is used on top of FDDI (FDDI is layer 1 and layer 2 of OSI stack) 2

Useful formulae and information for Question 1:

$$\tau' = \frac{d}{v} + \frac{Mb}{R} \qquad \frac{E[W]}{X} = \frac{\rho + a'\left(1 + \frac{\rho}{M}\right)}{2\left(1 - \left(1 + \frac{a'}{M}\right)\rho\right)} \qquad \rho_{max} = \frac{1}{1 + \frac{a'}{M}}$$

FDDI Frame Structure								
8 bytes	1 byte	1 byte	6 bytes	6 bytes	Variable Length	4 bytes	1 byte	1 byte
Preamble	SD	FC	Destination Address	Source Address	Information	FCS	ED	FS

2 **(9M)**

A With a diagram explain the CSMA-CA protocol. 2

B Assume that the number of data bits of payload data is the maximum of 2312 bytes. For the given PLCP frame formats and 802.11 physical layer stack, calculate the efficiency = (number of payload data bits)/(total number of bits) for 3

(i) Frequency Hopping Spread Spectrum (FHSS)

(ii) Direct Sequence Spread Spectrum (DSSS)

(iii) Infrared

C Assume that 802.11b standard is used with DSSS. The transmission of MPDUs with and without RTS/CTS is given in the diagram below. The message formats for RTS, CTS and ACK messages is also given below. The SIFS time is given in the standard to be 10 μseconds. The DIFS time is given to be 128 μseconds. It is also assumed that the PLCP Header is transmitted at 1 Mbps while all other information is transmitted at 11 Mbps. Assuming that the payload data size is 1024 bytes calculate the delay in the message in reaching the destination: i. With RTS/CTS and ii. Without RTS/CTS 4

FHSS PLCP Frame Format					
80 bits	16 bits	12 bits	4 bits	16 bits	Variable Length
Sync	Start Frame Delimiter	Length	Signaling	CRC	Payload Data
PLCP Preamble		PLCP Header			

DSSS PLCP Frame Format						
128 bits	16 bits	8 bits	8 bits	16 bits	16 bits	Variable Length
Sync	Start Frame Delimiter	Signal	Service	Length	CRC	Payload Data
PLCP Preamble		PLCP Header				

Infrared PLCP Frame Format						
128 to 292 bits	4 bits	3 bits	32 bits	16 bits	16 bits	Variable Length
Sync	Start Frame Delimiter	Data Rate	DC Level Adjust	Length	CRC	Payload Data
PLCP Preamble		PLCP Header				

RTS Message Format				
2	2	6	6	4
Frame Control	Duration	Receiver Address	Transmitter Address	FCS

CTS Message Format			
2	2	6	4
Frame Control	Duration	Receiver Address	FCS

ACK Message Format			
2	2	6	4
Frame Control	Duration	Receiver Address	FCS

Transmission of MPDU without RTS/CTS

Source	←DIFS→	Data		
			←SIFS→	
Destination				ACK

Transmission of MPDU with RTS/CTS

Source	←DIFS→	RTS				Data		
			←SIFS→		←SIFS→		←SIFS→	
Destination				CTS				ACK

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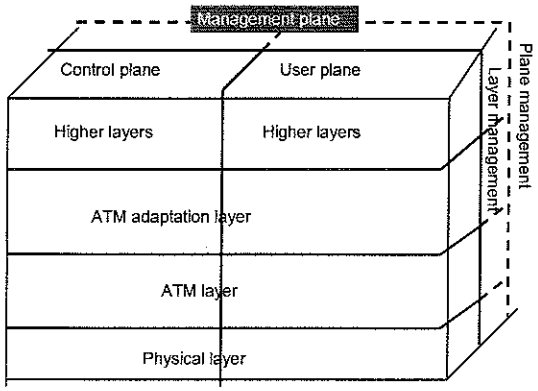
3		Which of the two protocols (FDDI and 802.11) would you use for	**(8M)**
	A	Voice information that can be assumed to be 48 bytes in each frame (all other information can be assumed as given in Question 1 and Question 3)? Justify.	4
	B	1500 byte information in each frame (corresponding to Ethernet frame size) (all other information can be assumed as given in Question 1 and Question 3)? Justify.	4
4			**(6M)**
	A	What is the approximate spectrum efficiency of the following standards: GSM and IS-95?	2
	B	Is it more efficient to transmit one 1 Mbit message or ten 0.1 Mbit messages? Why?	1
	C	For N = 16, n =4, k = 7, what is the total number of cross points in this multistage switch? What would the number of crosspoints in a crossbar switch for N = 16? Is it really a benefit to use multistage switch – explain?	3

PART-B

1		Let $g(x)=x^3+x+1$. Consider the information sequence 1001.	**(6M)**
	A	Find the codeword corresponding to the preceding information sequence.	3
	B	Suppose that the codeword has a transmission error in the first bit. What does the receiver obtain when it does its error checking?	3
2		A telephone modem is used to connect a personal computer to a host computer. The speed of the modem is 56 kbps and the one-way propagation delay is 100 ms. If the frame size is (i)256 bytes; (ii)512 bytes, assuming a bit error rate of 10^{-4}, Find the efficiency	**(8M)**
	A	for Stop-and-Wait ARQ and	2+2
	B	of Go-Back-N if three-bit sequence numbering. (Note some formulae given on the reverse side of this page)	2+2
3		Calls arrive to a pool of 50 modems according to a Poisson process. Calls have an average duration of 25 minutes.	**(6M)**
	A	What is the probability an arriving calls finds all modems busy if the arrival rate is two calls per minute?	3
	B	What is the maximum arrival rate that can be handled if the maximum acceptable blocking probability of 1%? 10%?	3
4		Describe TCP Window Flow Control with a suitable example.	**(7M)**
5		List any four Advantages of ATM Network	**(4M)**
6		In the BISDN Reference Model depicted in the figure below, offer a brief description & indicate the functions of the 3 planes and the 3 layers of the Model.	**(9M)**



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Some Formulae for Efficiency (Question No. 2 of PART- B)

$$\eta = \frac{\frac{n_f - n_o}{t}}{R} = \frac{1 - \frac{n_o}{n_f}}{1 + (W_s - 1)P_f}(1 - P_f)$$

$$\eta = \frac{R_{eff}}{R} = \frac{\frac{n_f - n_o}{t_0 / 1 - P_f}}{R} = \frac{1 - \frac{n_o}{n_f}}{1 + \frac{n_a}{n_f} + \frac{2(t_{prop} + t_{proc})R}{n_f}}(1 - P_f)$$

$$\eta = \frac{R_{eff}}{R} = \frac{\frac{n_f - n_o}{t_0}}{R} = \frac{1 - \frac{n_o}{n_f}}{1 + \frac{n_a}{n_f} + \frac{2(t_{prop} + t_{proc})R}{n_f}}.$$

$$\eta = \frac{\frac{n_f - n_o}{t_f / (1 - P_f)}}{R} = (1 - \frac{n_o}{n_f})(1 - P_f)$$

BITS Pilani Dubai Campus, International Academic City, Dubai, U.A.E.

II Semester, Academic Year 2010-11, B.E. (Hons.) ECE

TEST- II (Open Book)

ECE C394 COMMUNICATION NETWORKS

Date: 8th May, 2011 **Max. Marks: 40**
Duration: 50 mts **Weightage: 20%**

Note:- 1.Answer ALL the Questions.

- - -

1. In a CDMA Scheme, a channel's Walsh spreading sequence is (-1, 1, 1, -1). If following is the sum signal as received: (+1,-1,-1,-3), (-1,+1,-3,-1), (+1,-1,+3,+1),
   A. decode interpret the result you got [4 M]
   B. justify your answer. [2 M]
2. Suppose that a 1 MHz channel can support a 1 Mbps transmission rate. The channel is to be shared by 10 stations. Each station receives frames with exponential inter arrivals at rate λ =50 frames /second and frames are constant length L = 1000 bits. Compute the total frame delay if the system uses
   A. FDMA [3 M]
   B. TDMA [3 M]
   C. Comment on sensitivity to the no. of stations and & delay performance of FDMA in contrast to TDMA. [2 M]
3. Use the Bellman-Ford algorithm to find the set of shortest paths from all nodes to destination node 2, of the network (Fig.A). [6 M]

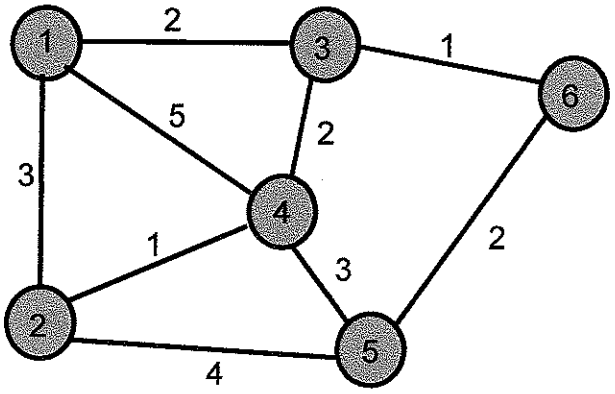


Fig. A.

4. For the data given below, assume Poisson arrivals, and independent and exponentially distributed service times. [1 + 3 + 2 + 2 = 8M]
   A. Determine ρ for each case where the corresponding table entry is empty.
   B. Determine the average waiting time (W) for a packet in the queue of a switching system for each row in the table where the corresponding entry is empty.
   C. Discuss the variation of the waiting time with ρ for a given a particular value of *m*.
   D. Discuss the variation of the waiting time with the number of servers given a particular value of ρ.

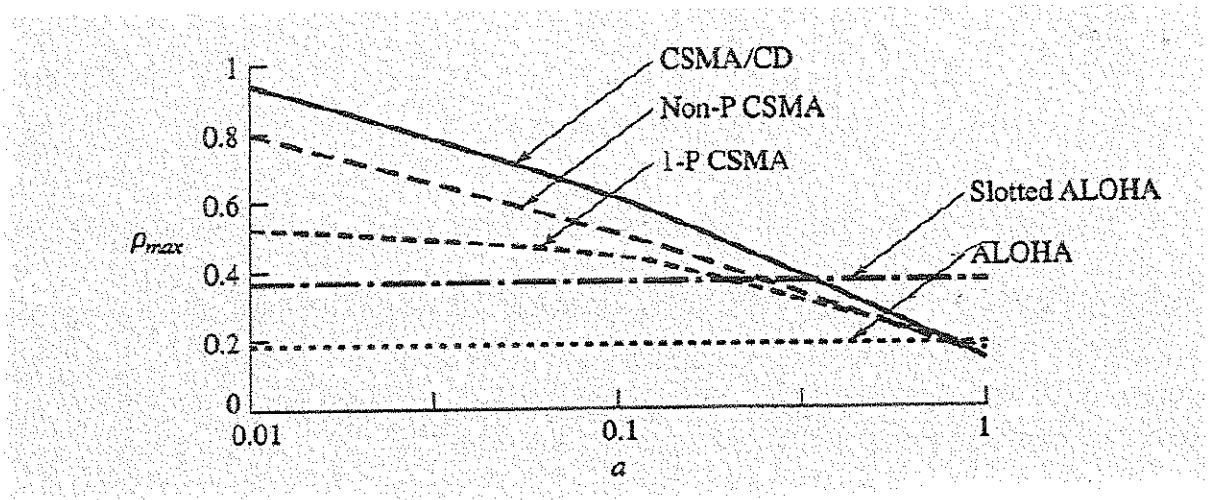
	λ	μ	m	ρ	P_0	W
1	1	10	1		9	
2	1	10	5	0.02	0.904837	1.57E-09
3	1	10	9		0.905743	
4	5	10	1	0.2	0.8	0.01
5	5	10	5	0.1	0.606529	3.9E-06
6	5	10	9	0.056	0.604109	4.39E-11
7	9	10	1	0.9	0.1	0.9
8	9	10	5	0.18	0.406531	5.95E-05
9	9	10	9	0.1	0.40657	5.95E-09

A.

5. Using the approximate expressions for the efficiencies of the following ARQ retransmission strategies in terms of L and P_f: Stop and Wait, Go-Back-N, and Selective Repeat, answer the following questions. [1.5 + 1.5 = 3 M]
   A. Can the efficiency of stop and wait strategy ever be 1? Justify your answer.
   B. Can the efficiency of stop and wait strategy ever be better than the efficiency of Go-Back-N? Justify your answer.

6. Using the expressions for total frame delay normalized to X, for the number of stations (M) being 100, are the delays significantly different for each of the systems? Justify your answer. [1.5 + 1.5 + 2 = 5M]
   A. Polling system
   B. Token ring system with limit of one frame per token with multitoken operation.
   C. Token ring system with one frame per token with the token insertion being done according to the single-frame operation.

   D. Assume that a reservation system is used with ALOHA, 1-persistent CSMA, non-persistent CSMA and CSMA-CD random access techniques. Using the information given in the diagram below, determine the maximum throughput for the reservation system when used with each of the 5 random access techniques. Assume that v = 0.05. [1 + 1 + 1 + 1 = 4M]



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BITS Pilani Dubai Campus, International Academic City, Dubai, U.A.E.

II Semester, Academic Year 2010-11, B.E. (Hons.) ECE

TEST- I (Closed Book)

ECE C394 COMMUNICATION NETWORKS

Date: 20th March, 2011
Duration: 50 minutes

Max. Marks: 50
Weightage: 25%

Note:- 1.Answer ALL the Questions.

- - -

1.

A. What are the seven layers in the OSI Reference Model? Briefly describe the basic communication functions of ***four lower*** layers. [1+4 = 5 M]

B. Which OSI layer is responsible for the following? [2x1=2 M]

i. Determining the best path to route packets.

ii. Providing end-to-end communications with reliable service.

2.

A. What is a connectionless packet switching approach? [2 M]

B. A 64-kilobyte message is to be transmitted over two hops in a network. The network limits packets to a maximum size of 2 kilobytes, and each packet has a 32-byte header. The transmission lines in the network are error free and have a speed of 50 Mbps. Each hop is 1000 km long. How long does it take to get the message from the source to the destination? [6 M]

3.

A. In a typical communication network, briefly describe how occurrence of single bit errors are handled employing single parity check codes. [3 M]

B. Suppose that two check bits are added to a group of 2n information bits. The first check bit is the parity check of the first n bits and the second check bit is the parity check of the second n bits. Characterize the error patterns that can be detected by this code. [5 M]

4. ATM header error check uses CRC-8. CRC-8 uses the generator polynomial $g(x) = x^8 + x^2 + x + 1$.
Determine if there is an error in transmission if the received vector is

A. (1,1,0,0,0,0,1,0,0,1,0,0,0) [4 M]

B. (1,1,0,0,1,0,1,0,0,1,0,0,0) [4.5 M]

5. Design a small multistage switch that supports 32 inputs and 32 outputs.

A. Choose 4 appropriate values for the number inputs (*n*) into each input block. [2 M]

B. Determine 4 corresponding values for *k* for switch to be non-blocking. [2 M]

C. Determine the number of crosspoints required for each of the *four* combinations of *n* and *k*. [4 M]

D. If you could choose between a multistage switch with the above *four* configurations of multistage switch and a 32-by-32 crossbar switch, which would you choose? You should make four design choices (one for each configuration). [2 M]

(Please Turn Over)

6. Retransmission strategies.

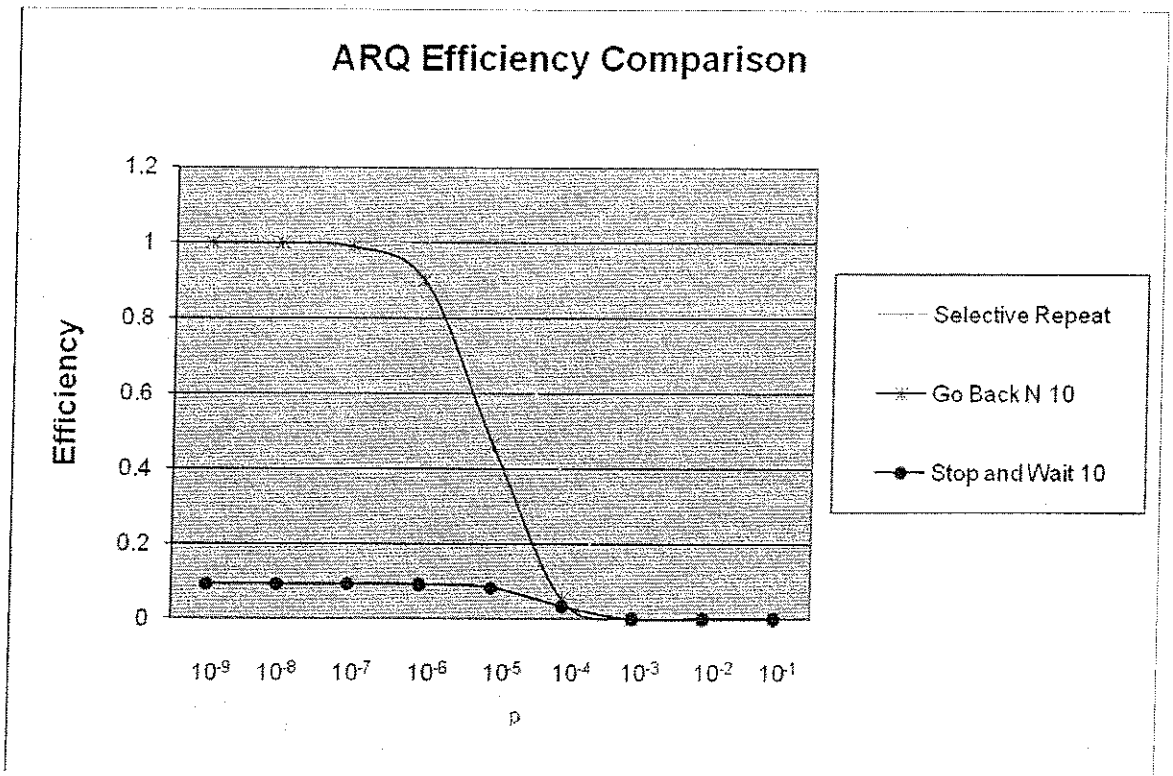
A. Does it make sense to have retransmission strategies for VoIP (using UDP, IPv6)? Explain. [2.5 M]

B. Assume packets are transmitted over IEEE 802.3 Ethernet type. The speed of signal in the coaxial cable is 0.77c (c is speed of light = $3x10^8$ m/sec) and a data rate of 10 Mbps is supported. Assume the distance between sender and receiver to be 500 m. Assume data packets of size 1000 bytes. Compute the parameter *N* in **Go Back N** retransmission strategy assuming:

   a. ACK packets of size of 40 bytes are sent by the receiver as soon the packets are received. [2 M]

   b. ACK is piggybacked to the packet sent by the receiver. Assume that the receiver operates in a similar manner to the sender and sends 1000 byte packets. [2 M]

C. Consider the comparison of ARQ strategies in figure below. Which strategy would you use for random bit errors (p) of 10^{-4} and 10^{-8}? Justify your answer. [2 M]



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Student Name_____ ID. No._____

BITS-Pilani Dubai, Dubai International Academic City, Dubai

III Year B.E. (Hons.), Second Semester Academic Year 2010 – 2011

QUIZ II (Closed Book); ECE C394 COMMUNICATION NETWORKS

A

Date : 13.04.2011 Max Marks : 16

Duration : 20 mts. Weightage : 8%

Questions for setting Quiz II paper:

1) On a network gateway, measurements show that the packets arrive at a mean rate of 125 packets per second, and the gateway takes about 2 ms to forward them. Using M/M/1 model, analyze the Gateway:
   A) What is the mean time spent in gateway? [1 M]
   B) What is the mean number of packets in gateway? [1 M]
   C) What is the probability of buffer/queue overflow if the queue can only hold 13 packets?[1.5 M]
   D) What size of buffer/queue do we need to keep packet loss below one packet per million? [1.5 M]

2) A telephone company establishes a direct connection between two cities expecting Poisson traffic with rate 5 calls/min. Inter-arrival times are independent of call durations. Duration of calls are independent and exponentially distributed with mean 1 min. Assuming that blocked calls are lost (i.e., a blocked call is not attempted again), how many circuits should the company provide to ensure that an attempted call is blocked (because all circuits are busy) with probability less than 0.5? [3 M]

3) For the 16-bit data 1101100001100101, answer the following questions: (1+1.5+1.5= 4M)

A) Determine the parity bit (EP) assuming that a single-bit even parity scheme is used i.e., 1101100001100101 **EP**

B) Now consider the transmitted data to be of the form: 1101 **EP1** 1000 **EP2** 0110 **EP3** 0101 **EP4**.

(i) How many bit errors can this scheme detect?

(ii) What is the efficiency of the transmitted data?

4) For CRC method of error detection and correction, assume that the transmitted polynomial is $b(x) = x^{n-k} i(x) + r(x)$ where i(x) is the information polynomial. The degree of the generator polynomial (the highest power in the polynomial), g(x), in CRC-16 is 16. The degree of i(x) is 8. What is the efficiency (defined as ***(Number of data bits/Total Number of bits)x100***) of the transmission? (2M)

5) Assume that there are 10 packets to be transmitted. Normal sequence of transmission without error conditions is P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}. Assuming that every even packet fails to reach the destination node in the first attempt but is successful in the second attempt.

(1 + 1 = 2M)

A) If Stop and Wait ARQ protocol is used, what would be the sequence of packets sent by the sender?

B) What is the efficiency of the system (defined as the ratio of "(***Number of data packets that needed to be sent/total number of packets actually sent)x100***)?

Student Name_____ ID. No._____

BITS-Pilani Dubai, Dubai International Academic City, Dubai

III Year B.E. (Hons.), Second Semester Academic Year 2010 – 2011

QUIZ II (Closed Book); ECE C394 COMMUNICATION NETWORKS

B

Date : 13.04.2011 Max Marks : 16

Duration : 20 mts. Weightage : 8%

Questions for setting Quiz II paper:

1) On a network gateway, measurements show that the packets arrive at a mean rate of 100 packets per second, and the gateway takes about 5 ms to forward them. Using M/M/1 model, analyze the Gateway:
   A) What is the mean time spent in gateway? [1 M]
   B) What is the mean number of packets in gateway? [1 M]
   C) What is the probability of buffer/queue overflow if the queue can only hold 15 packets?[1.5 M]
   D) What size of buffer/queue do we need to keep packet loss below two packet per million? [1.5 M]

2) A telephone company establishes a direct connection between two cities expecting Poisson traffic with rate 10 calls/min. Duration of calls are independent and exponentially distributed with mean time 30 sec. Inter-arrival times are independent of call durations. Assuming that blocked calls are lost (i.e., a blocked call is not attempted again), how many circuits should the company provide to ensure that an attempted call is blocked (because all circuits are busy) with probability less than 0.5? [3 M]

3) For the 16-bit data 0001100001100111, answer the following questions: (1+1.5+1.5= 4M)
   A) Determine the parity bit (EP) assuming that a single-bit even parity scheme is used i.e., 0001100001100111 **EP**
   B) Now consider the transmitted data to be of the form: 0001 **EP1** 1000 **EP2** 0110 **EP3** 0111 **EP4**.
      (i) How many bit errors can this scheme detect?
      (ii) What is the efficiency of the transmitted data?

4) For CRC method of error detection and correction, assume that the transmitted polynomial is $b(x) = x^{n-k}\, i(x) + r(x)$ where i(x) is the information polynomial. The degree of the generator polynomial (the highest power in the polynomial), g(x), in CRC-32 is 32. The degree of i(x) is 7. What is the efficiency (defined as ***(Number of data bits/Total Number of bits)x100***) of the transmission? (2M)

5) Assume that there are 11 packets to be transmitted. Normal sequence of transmission without error conditions is P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10} P_{11}. Assuming that every even packet fails to reach the destination node in the first attempt but is successful in the second attempt.

(1 + 1 = 2M)

A) If Stop and Wait ARQ protocol is used, what would be the sequence of packets sent by the sender?

B) What is the efficiency of the system (defined as the ratio of "(***Number of data packets that needed to be sent/total number of packets actually sent)x100***)?