GX557

OLLSCOIL NA hÉIREANN, GAILLIMH
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 1999

B.E. DEGREE EXAMINATION (ELECTRONIC ENGINEERING)

COMMUNICATION SYSTEMS ENGINEERING

Professor L. E. Davis
Professor D.J. Wilcox
Mr. L. Kilmartin

Duration of examination: *Three* Hours

Instructions: Answer *Question 1* and any *Four* other questions.

1. *(a)* A Hamming coding scheme is to be implemented to protect the transmission of 12 bit data blocks within a communication system.

(i) Determine the minimum number of additional error protection bits which must be added to each of the 12 bit information blocks,
(ii) A particular 12 bit information block requiring error protection contains the hexadecimal pattern 4E7. Determine the values and locations of the additional Hamming code error protection bits (assuming basing the Hamming code on even parity).
(iii) Illustrate the ability of a Hamming code to handle ONLY single bit errors by firstly analysing a received data block consisting of the data block transmitted in part (b) but with bit 7 "errored". You must then repeat this process by simulating the reception of the block transmitted in (b) but with both bits 5 and 13 "errored".

[12 marks]

(b) A source coding subsystem must be designed to allow the transmission of data from a remote environmental monitoring unit. This data, which indicates the state of the monitor, is represented by a 3 bit pattern. It is decided to examine the data being produced by the sensor before the source coding module is designed. Over a 48 hour period the number of occurrences of each of the eight possible three bit patterns in the data generated by the sensor was counted by an automatic logging system. The results of this log were:

Symbol	000	001	010	011	100	101	110	111
Number of Occurrences	52	87	23	14	7	65	42	39

It was felt that this log accurately represented the long term behaviour of the system being monitored. You are required to design a Huffman source coding scheme for this system based on the information presented above.

Determine the efficiency of the source coding module that you have designed.

[8 marks]

2. *(a)* Describe the purpose of, and functions implemented by, a standard ***subscriber line interface circuit*** in the PSTN.

[5 marks]

[pto]

(b) Describe, with the aid of a diagram, the structure of the primary E1 TDM multiplex which is used within the PSTN. Indicate clearly the structure and function of the various timeslots which make up the frame.

[4 marks]

(c) Signaling information relating to specific voice calls in the PSTN can be conveyed between exchanges over an E1 TDM link using any of the three techniques below:

(i) Digitised in-band tones,
(ii) TS16 based bit toggling,
(iii) Multi-byte digital messages.

For each technique:

(i) Explain, using a specific example, how precisely the signaling information is conveyed over the E1 TDM link,
(ii) Clearly explain why the technique is either a CAS or CCS protocol, and
(iii) Indicate ***one*** advantage and disadvantage of the technique.

[6 marks]

(d) A large office block is serviced by a PBX with 250 internal extensions which also requires connection to the external PSTN. It is estimated that the busy hour requirement for external connections from the PBX to the PSTN is to carry 30 calls with an average duration of 4 minutes. Determine an acceptable number of TDM channels for this external link in order to carry this traffic with an acceptable GOS. State clearly the origin of all figures used in your calculation.

Erlang's B formula is given by :

$$E_1(n, A_0) = \frac{\frac{A_o^n}{n!}}{\sum_{i=0}^{n} \frac{A_o^i}{i!}}$$

[5 marks]

3. *(a)* Explain, citing examples, what you understand by the terms ***physical layer protocol, data link layer protocol*** and ***network layer protocol*** in the context of data communication protocols.

[5 marks]

(b) Explain, with the aid of a diagram, the difference between ***synchronous*** and ***asynchronous*** data transmission.

A link between two DTE operates at a bit rate of 64kbps. One DTE needs to transmit blocks of 130 bytes over this link. Calculate the maximum efficiency of the link if the data is transmitted using :

(i) asynchronous transmission with a frame structure of 7 data bits, one parity bit, one start bit and one stop bits,
(ii) synchronous transmission with a maximum block size of 64 data bytes. Each block is encapsulated within a start of frame and end of frame byte and preceded by two synchronisation bytes.

Estimate **both** efficiencies if the transmission link has a relatively high BER, say 1 in 1000, and no error correction is included in the system.

[10 marks]

[pto]

(c) Describe what are meant by the following terms in the context of a Continuous RQ data link protocol:

(i) Frame Sequence Numbers,
(ii) Flow Control,
(iii) Receive and Transmit station frame buffers,
(iv) Re-transmission State.

[5 marks]

4. *(a)* Outline, with the aid of a diagram, the operation of the CSMA\CD protocol, particularly as implemented in the 802.3 LAN standard.

Explain clearly the two mechanisms by which collisions can still occur when this protocol is in operation.

[7 marks]

(b) In an 802.5 ring, it is the responsibility of the station which transmitted a frame to remove it from the ring and to re-generate the token. Outline **three** implications of altering this protocol so that it is the responsibility of the station receiving a frame to remove the frame from the ring and to ensure that the token is re-generated.

[3 marks]

(c) Describe, with the aid of diagrams, the function of a ***bridge*** in a LAN and also outline the different classes of bridges which may be used in a LAN.

[5 marks]

(d) A standard 802.5 Token Ring LAN has 10 active stations operating on the ring. On observing the performance of the active monitor, it was noted that the active monitor was inserting 5 **extra** single bit delays into the rotation time of data on the ring in order to maintain the required minimum latency. The velocity of signal propagation on all links forming the ring is 2.5×10^8 ms^{-1}.

Determine the possible range of values for the total physical length of cable forming the ring,

[5 marks]

5. *(a)* Describe, with the aid of a diagram, the functional model for an ISDN basic rate interface. Clearly explain what is meant by each ***functional block*** and ***reference point***. Also indicate the relationship between the blocks in the diagram and the subscriber's premise, the local loop and the local ISDN exchange.

[6 marks]

(b) Explain why the physical protocol for the U interface on the ISDN reference model is not formally outlined within the international ISDN specification.

A particular national ISDN provider is using HDB3 line coding to carry ISDN over the local loop. Determine the waveform which would be transmitted for the following bit sequence.

0010 0001 1001 0010 0000 1010

Clearly indicate all ***violation pulses*** and ***protection pulses*** in the transmitted voltage waveform.

[5 marks]

(c) Explain, using examples, what is meant by the following terms in the context of ISDN :

(i) Bearer Service,
(ii) Supplementary Service,
(iii) Teleservice.

[5 marks]

[pto]

(d) Describe briefly ***any*** of the new technologies which are currently being developed and deployed for broadband network access and high bit rate delivery to the subscriber.

[4 marks]

6. *(a)* Explain, with the use of diagrams, the essential differences between ***FH-CDMA*** and ***DS-CDMA*** in the context of accessing protocols for satellite communication networks.

[6 marks]

(b) A TDMA satellite network has the following operating characteristics:

Earth station transmission rate:	200 Mbps
Frame Length:	25 μs
Timeslots per frame:	10 timeslots per frame
Transmission preamble:	20 bits
Guard time:	10% of timeslot duration

In addition, the first timeslot of each frame is used by the network control station to transmit a reference burst of 40 bits with no other data. The transmission preamble is transmitted by all earth stations using a timeslot before the transmission of the earth station data traffic.

Estimate (to the nearest byte) the maximum length of traffic data that each earth station can transmit in a single timeslot, and hence deduce an efficiency value for this TDMA format

[4 marks]

(c) Explain, in the context of satellite channel capacity, what is meant by the **terms** ***speech compression (coding)*** and ***Digital Speech Interpolation (DSI)***.

An E1 PCM TDM frame structure is used on an inter-continental satellite communication link with a DCME on either end of the link. The normal E1 frame structure is used on this link and a defined 64 kbps is permanently assigned to handle signalling traffic over the link. In addition, sufficient bit rate to handle 3 transparent terrestrial ISDN B channels must always be kept available on the satellite link. The digital signal processing (DSP) functionality in the DCME is capable of supporting 32 kbps ADPCM compression for terrestrial channels. In addition, this functionality is capable of dropping this bit rate to 16 kbps ADPCM in order to create overload channels. An operating constraint on the link is that the number of overload channels must always be equal to the five times the number of 32 kbps ADPCM channels.

Determine the maximum number of terrestrial channels that this satellite link can support when operating under this constraint, ignoring any DSI functionality in the DCME.

[10 marks]

7. *(a)* Explain, with the aid of diagrams, the term ***cell*** and ***frequency reuse*** in the context of cellular telephony networks.

[3 marks]

(b) Describe, with the aid of a diagram, the function of, and relationship between, the following entities in a GSM cellular network:

(i) Mobile Station,
(ii) Base Transceiver Station,
(iii) Base Station Controller,
(iv) Mobile Switching Centre,
(v) Home Location Register,
(vi) Visitor Location Register,

Explain, in terms of the relevant entities above, how an incoming voice call is routed to, and answered by, a GSM mobile terminal.

[10 marks]

(c) Describe what you understand by the term ***handover*** in the context of GSM networks.

[3 marks]

(d) Explain when, and why, a Random Access Burst is transmitted by a GSM mobile station in a channel timeslot.

The random access burst has a duration of 88 bits at the GSM transmission bit rate of 270 kbps. Given that a single GSM channel timeslot has a duration of 156.25 bits, show that the maximum size of a GSM cell is just under 40 km.

[4 marks]