UNIVERSITY OF CAMBRIDGE

ENGINEERING TRIPOS PART IIA

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Tuesday 4 May 2004 2.30 to 4

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Module 3F5

COMPUTER AND NETWORK SYSTEMS

*Answer not more than **three** questions.*

*All questions carry the same number of marks.*

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

*There are no attachments.*

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the Invigilator

(TURN OVER

1 (a) Define the following terms when used to describe computer networks and give an example of a typical application or scenario for each one: *packet switch*, *protocol*, *modem*, *latency*. [30%]

(b) Describe how the *CSMA/CD* (Carrier Sense Multiple Access with Collision Detection) *MAC* (Medium Access Control) protocol is utilised within a 10 Mbit Ethernet *LAN* (Local Area Network). Under what sort of traffic conditions will a CSMA/CD LAN perform poorly? [35%]

(c) Discuss (with examples if relevant) how, with increasing data rates, the Ethernet protocol has evolved into a suitable protocol for *MANs* (Metropolitan Area Networks) and even *WANs* (Wide Area Networks). Show that, in the context of MANs and WANs, there is very little difference between Ethernet and frame relay. [35%]

2 (a) Explain what is meant by a *physical layer process* in the *OSI* (Open Systems Interconnect) seven layer reference model. [10%]

(b) Describe the basic operation of the *GSM* (Global System for Mobile communications) protocol in modern wireless mobile phones. Is GSM a purely physical layer process? [25%]

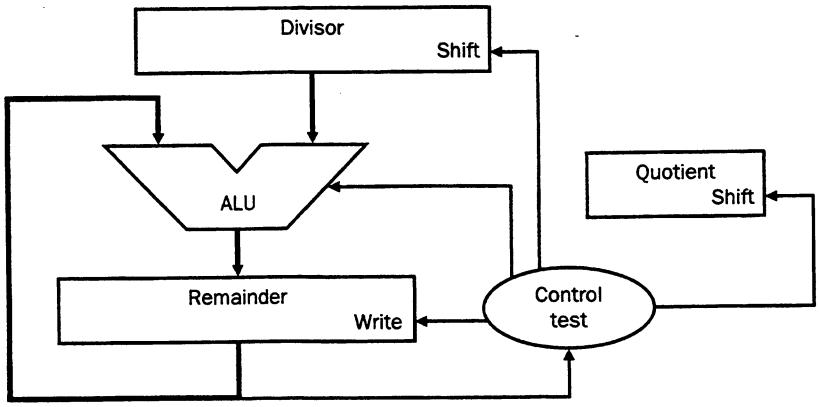
(c) If two V.33 land line modems were connected via a standard GSM audio connection instead of a conventional land line, how would the data rate and bit error rate be affected? Suggest two possible solutions to this problem which might be implemented. [20%]

(d) Explain how an *ADSL* (Asymmetric Digital Subscriber Line) modem can be used to increase significantly the bandwidth of a standard copper wire twisted pair land-line. Could ADSL be used on a mobile wireless channel? [25%]

(e) Describe how an ADSL modem interfaces with both the telecommunications and computer networks at the exchange end. Why are the two services not transported together? [20%]

3 You are interested in circuitry to perform integer division in hardware. Assume that dividend and divisor are > 0 and therefore that quotient and remainder are ≥ 0. All quantities are represented as 4 bits wide, in 2's complement.

(a) The diagram below is a basic non-optimized circuit to perform binary division. Label all buses and registers with their widths and the two shifting registers with arrows indicating the direction of the shift. Briefly explain how the circuit works and then provide a complete and detailed description using a clear flow chart. [40%]




(b) Trace out the execution of dividing seven by three using this circuit. [25%]

*(Hints on tracing: Draw a table with a column for each of the registers in your design, plus an extra column for comments. Follow the execution by writing out a new line in the table for every event, updating any values that change, and explaining what happened in the comment column.)*

(c) In what ways could you optimize the design so that it would use less circuitry? Draw a new circuit, explain how it would work and provide a new flow chart for it. [35%]

4 (a) Explain how a set-associative cache works. What is the cache tag? Why is it useful? Draw a diagram of a 4-way set-associative cache and show where the tag fits. [40%]

(b) Given the byte address 0x6717, state where exactly in the cache a byte fetched from that address will be loaded, in each of the cases below. *("Where exactly in the cache" means which byte of which word of which block and, if appropriate, of which set.)* State also what the value of the cache tag will be and how many bytes of data fit in that type of cache. Briefly explain how you obtain all these values. Assume words are 32 bits wide. *(You may use hex notation where appropriate, but prefix numerals with 0x wherever you do so.)*

(i) Direct-mapped cache, 8 words per block, 4 blocks.

(ii) Set-associative cache, 4 words per block, 4 blocks per set, 16 sets.

(iii) Fully associative cache, 4 words per block, 16 blocks. [60%]

**END OF PAPER**

Q4.b Numerical answer