UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2003

BEng Honours Degree in Computing Part II
MEng Honours Degrees in Computing Part II
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the Associateship of the City and Guilds of London Institute

PAPER C212

NETWORKS AND COMMUNICATIONS

Tuesday 6 May 2003, 14:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

Equations that *might* be used in answering the questions

$$\log_2 x = \frac{\log_{10} x}{\log_{10} 2}$$

b	Average number of bits of information each symbol represents
P_i	Probability of symbol number i occurring
n	Total number of symbols

$$b = -\sum_{i=1}^{n} P_i \log_2 P_i$$

C	Bit rate
B	Bandwidth in Hz
L	Number of distinct signal levels
$\frac{S}{N}$	Signal to noise ratio

$$C = 2B \log_2 L$$

$$C = B \log_2 \left(1 + \frac{S}{N}\right)$$

The following are equations for queuing theory with M/M/1 queues and Poisson distributions.

m	Number of arrivals expected in a period of time t
$P_{n,m}$	Probability of n arrivals if m are expected
λ	Mean arrival rate at a queue
μ	Mean serving rate of a queue
l	Mean length of a queue
d	Mean delay in the system
P_k	Probability that a k size buffer blocks

$$P_{n,m} = \frac{m^n}{n!} e^{-m}$$

$$m = t\lambda$$

$$\rho = \frac{\lambda}{\mu}$$

$$l = \frac{\rho}{1 - \rho}$$

$$d = \frac{1}{\mu - \lambda}$$

$$P_k = \frac{(1 - \rho)\rho^k}{1 - \rho^{k+1}}$$

1a Which layer of the OSI model would you *most* associate with each of the following:

i) UTP and STP cabling
ii) Provision of reliable end-to-end connections
iii) IP addressing
iv) Automatic repeat request (ARQ)
v) Run length coding
vi) Login procedures
vii) WWW server process

b Briefly explain why *store-and-forward* causes longer packets to suffer greater delays than shorter packets. In a particular network, a 10,000 bit packet passes through a network operating at $1Mbs^{-1}$, and on route passes through two routers operating store-and-forward, and 200km of cable with propagation speeds of $200 \times 10^6 ms^{-1}$. How long after the start of transmission is it before the receiver has the complete packet?

c A Web browsing session visits the following URLs in order:

http://www.doc.ic.ac.uk/index.html
ftp://kiwi.doc.ic.ac.uk/README
http://www.doc.ic.ac.uk:8080/index.html

Briefly explain your answer to each of the following:

i) How many DNS lookup operations will the browser need to perform in the session?
ii) If the browser was situated in the java.sun.com domain, and made a request for an iterative lookup of addresses from its local DNS server, what are the domains that the DNS server contacts for the lookup of the first URL in the list above. (It must be assumed that each level in the DNS hierarchy is in a different zone, and that all servers have no cached information.)
iii) How may server processes will be contacted by the browser during the session?
iv) For the first and last URL, how is the server socket constructed?
v) If the session was extended to send an email to notab@kiwi.doc.ic.ac.uk, is a new DNS request required?
vi) DNS does not provide user defined record types, but you are required to add details of the owner and telephone number of each machine in the doc.ic.ac.uk domain, which can be retrieved by outside clients using DNS. Can you suggest a method to achieve this?
vii) Explain if it would be possible or not to use a firewall to block access to http://www.doc.ic.ac.uk/c212_exam.ps but allow access to all the URLs listed in the web browsing session.

The parts carry, respectively, 14%, 24%, and 62% of the marks

2a Write down the run-length encoding of 11000000010001, if the run-length encoding uses codewords of 3-bits.

What data does the run-length coding 111111000 represent, if the run-length encoding uses codewords of 3-bits?

b A continuous-RQ go-back-N protocol is being used on a $1Mbs^{-1}$ link between two sites $1,000km$ apart, where the speed of propagation is $200 \times 10^6 ms^{-1}$, the BER is 10^{-4} and the I-frame size 1,000bits. Calculate the efficiency of the system, and compare it to the efficiency that you calculate an idle RQ protocol would have in the same system.

c The following table contains information extracted from the data sheets of a certain communications system which conforms to the OSI model. All fields are of fixed size.

	Size in Bytes		
Layer	ICI	PCI	SDU
Transport	10	64	64000
Network	6	20	2000
Data Link	6	44	6000

i) What information in the table does not directly effect the amount of data sent over the network?

ii) What process must be used to send a T-PDU over the network layer? How many N-PDUs are required to send one T-PDU?

iii) If we wish to minimise usage of bandwidth and the number of PDUs processed at the receiver, what process might be employed in the data link layer when sending an N-PDU? Using this process, how many D-PDUs are required to send one T-PDU?

The parts carry, respectively, 24%, 38% and 38% of the marks

3a A 2.56Mbs^{-1} channel is being used to connect a network router to the College network. The router serves eight hosts, each via a separate link operating at 400kbs^{-1}. The hosts are found to each generate on average 30 packets per second of average length 1000 bytes, and the router serves to forward all the packets over the 2.56Mbs^{-1} channel onto the College network.

Calculate the mean number of packets either at the router or being transmitted from the router onto the 2.56Mbs^{-1} channel when:

i) Packets are STDM by the router onto the channel

ii) The router divides using TDM the channel into eight channels of 320kbs^{-1}, and each host has sole use of one of these channels.

b You have been asked to design an IPv4 addressing scheme for a Class B network 137.73.0.0, where you are told that there are 15 departments, and at present a maximum of 900 machines in each department, and you are required to allow for 20% growth in both figures.

i) Calculate what would be the appropriate subnet mask to use.

ii) For the subnet mask you have calculated in (i), demonstrate which of the following hosts are within the same subnet.

A. 137.73.7.253

B. 137.73.8.1

C. 137.73.15.253

D. 137.73.16.240

iii) Use you answer for (ii) to outline if a gateway (or router) must be used for the following communications, and which MAC address the sending host must obtain when making the following IP communications:

A. host A sending an IP packet to host B.

B. host B sending an IP packet to host C.

c If an even parity check has been included in the following codewords, identify which are guaranteed correct, and which are guaranteed incorrect, and which you cannot be sure about.

i) 11111111_2

ii) 00000000_2

iii) 10101110_2

iv) 11010110_2

The three parts carry, respectively, 34%, 46%, and 20% of the marks

4a A channel has a bandwidth of 20kHz, and a system of amplitude modulation using 16 signalling levels is in use.

i) What is the maximum bit rate that the channel may support?

ii) What is the maximum signal-to-noise ratio in dB that may be present on the channel before this throughput is reduced?

b Briefly explain how public key encryption works, in terms of how a message M must be encrypted at the transmitter and decrypted at the receiver, if communication is to be confidential and authenticated.

A particular distributed system has the following distribution of keys K on hosts H, where $M \equiv D(K_n^{-1}, E(K_n, M))$:

$H_1 : K_1, K_1^{-1}, K_3^{-1}$

$H_2 : K_2, K_2^{-1}, K_3^{-1}$

$H_3 : K_3, K_5, K_1^{-1}, K_2^{-1}, K_3^{-1}$

$H_4 : K_1^{-1}, K_2^{-1}, K_3^{-1}$

Explain (by listing the messages exchanged) how the above keys can be used so that H_1 may send a confidential and authenticated message to H_2, if H_3 can be trusted, and H_4 is known to be controlled by the enemy.

c Show the encoding of the pattern 11001_2 in bipolar and in differential synchronous transmission scheme.

d The table below shows average traffic rates on a single LAN between four hosts, where the LAN is currently running at its maximum capacity. Give a division of the LAN into two subnets separated by a bridge which minimises the total load on both subnets. Clearly state in your answer what are the two groups of hosts, and what is the load on each subnet, as a percentage of the maximum load the subnet may support.

		To			
		H_1	H_2	H_3	H_4
From	H_1	–	50	20	450
	H_2	60	–	900	0
	H_3	50	50	–	50
	H_4	800	40	40	–

The parts carry, respectively, 24%, 32%, 24% and 20% of the marks