E3.17
SO8
ISE3.31

IMPERIAL COLLEGE LONDON

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
EXAMINATIONS 2008

MSc and EEE/ISE PART III/IV: MEng, BEng and ACGI

Corrected Copy

COMMUNICATION NETWORKS

Tuesday, 13 May 10:00 am

Time allowed: 3:00 hours

There are SIX questions on this paper.

Answer FOUR questions.

All questions carry equal marks

Any special instructions for invigilators and information for candidates are on page 1.

Examiners responsible   First Marker(s) : J.A. Barria
Second Marker(s) : P.J. Beevor

Special instructions for students

1. Mean delay for the M/M/1 system may be taken as

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

where

λ = arrival rate at M/M/1 system [packets / s], and

μ = service rate of M/M/1 system [packets / s].

1.

a) For a simplified version of automatic repeat request (ARQ) scheme:

$$a = \frac{\text{propagation time}}{\text{trasmission time}}$$

i) Derive a simple expression for the performance of the selective repeat ARQ mechanism with window size equal to 2 packets. Consider that a single frame is in error with probability P = 0.01 and a = 1. [5]

ii) Derive a simple expression for the performance of the selective repeat ARQ mechanism with window size equal to 4 packets. Consider that a single frame is in error with probability P = 0.01 and a = 1. [5]

b) *N* computer terminals are conected using a *LAN* 1-persistent CSMA/CD protocol. If the probability that a station transmits during an available time slot is P,

- Derive the probability that a successful transmission will take *j* attempts.

[10]

2.

a)

i) Describe and discuss the operations of an LEO satellite system. What is its main difference from other satellite systems (e.g. GEO and MEO) ?.

[5]

ii) Describe and discuss all possible handovers that need to be considered in an LEO satellite system.

[5]

b) The steady state solution of a two-state voice source model is given by

$$\Pi = \left[\frac{\lambda}{\alpha+\lambda}, \frac{\alpha}{\alpha+\lambda}\right]$$

i) Define and explain the parameters α and λ.

[3]

ii) For *N*-multiplexed independent sources, derive the steady state probability of having *i* sources on.

[7]

3.

a) The network of Fig 3.1. has been formed by the inter-connection of two sub-networks namely,
Sub-network A nodes {1, 2, 3, 4} and,
Sub-network B nodes {4, 5, 6, 7}

i) Solve the Optimal Routing Problem for the O-D demand $R(1,7) = 10$ [kbit/s] for the network of Figure 3.1.

[10]

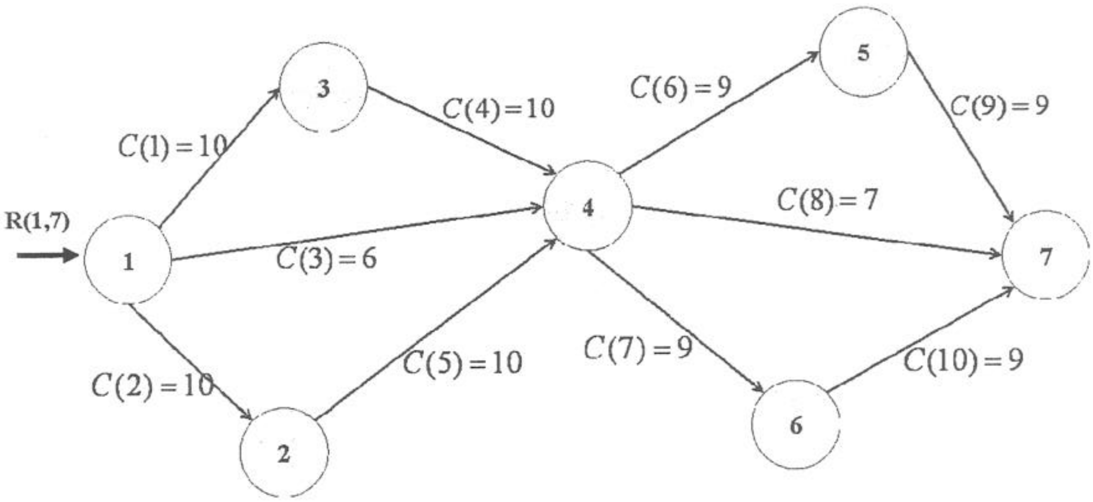
b) If you have the possibility of increasing up to 1 [kbit/s] of capacity between any two points of one particular sub-network,

i) Suggest possible ways of lowering the level of network congestion.

Explain your decision.

What will be the new mean network delay?

[10]



Note: All capacities in the network *C(i)* are given in [kbit/s]

Figure 3.1

4.

a)

i) Describe and discuss the Bellman-Ford shortest path algorithm.

[5]

ii) Describe and discuss Dijstra's shortest path algorithms.

[5]

b)

i) For the network of Figure 4.1. show clearly the iterative sequence of the Bellman-Ford algorithm.

[5]

ii) For the network of Figure 4.1. show clearly the iterative sequence of Dijstra's algorithm.

[5]

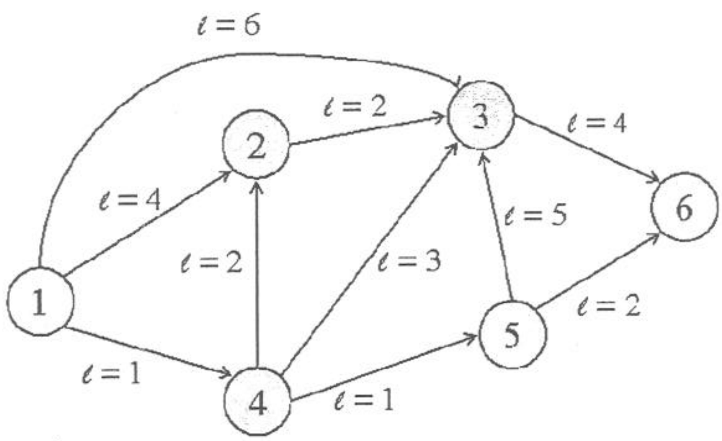


Figure 4.1

5.

a)

i) Briefly discuss the advantages of implementing DiffServ over Multi-Protocol Label Switching.

[6]

ii) Discuss the main benefits that Multi-Protocol Label Switching brings to IP-based network.

[7]

b) In the context of an ATM networks the equivalent capacity function can be expressed by:

$$C^* = \min[G\_F, G\_S]$$

with G_F and G_S a function of $= (R_p, b, n, u, x)$

- Define and discuss the meaning of the variables R_p, b, n, u and x.

[7]

6. For the network in Figure 6.1

a) Derive the expression for the mean number of outstanding packets in the network.

[10]

b) Derive the value of the capacity C(4) for the traffic γ_{14} to split into two routes.

[10]

Notation:

$1/\mu$ = average length of packet = 1000 [bits/packet]

γ_{ij} = arrival rate (node i to node j) [packets / s]

$\gamma_{14} = 3$[kbit/s]; $\gamma_{21} = 2$[kbit/s]; $\gamma_{34} = 2$[kbit/s]; $\gamma_{31} = 2$ [kbit/s]

$C(i) = 10$[kbit/s] for i = 1,...,5

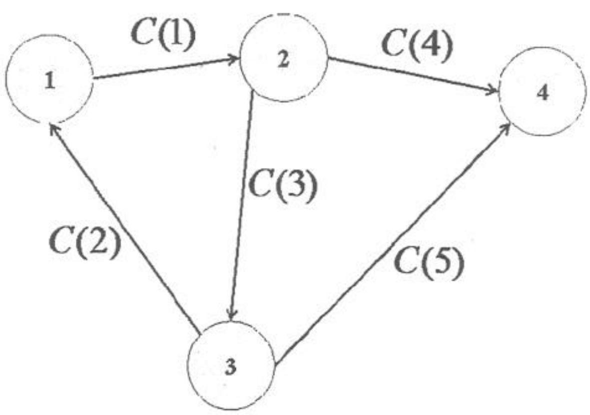


Figure 6.1