



**6G7Z1004 : ADVANCED COMPUTER NETWORKS AND OPERATING
SYSTEMS**

Duration : 3 hours

Instructions to Candidates

Answer **TWO** Questions from **SECTION A** and **TWO** Questions from **SECTION B**.

Calculators are permitted.

SECTION A – Answer **TWO** questions.

1.
 - (a) In the context of Ethernet, explain the key advantage of physical network segmentation. [5]
 - (b) Consider two mobile nodes in a foreign network having a foreign agent. Is it possible for the two mobile nodes to use the same care-of address in mobile IP? Explain your answer. [8]
 - (c) Consider the following idealised LTE scenario. The downstream channel is slotted in time, across F frequencies. There are four nodes, A, B, C, and D, reachable from the base station at rates of 10 Mbps, 5 Mbps, 2.5 Mbps, and 1 Mbps, respectively, on the downstream channel. These rates assume that the base station utilises all time slots available on all F frequencies to send to just one station. The base station has an infinite amount of data to send to each of the nodes, and can send to any one of these four nodes using any of the F frequencies during any time slot in the downstream sub-frame.

If there is a fairness requirement that any node can receive at most twice as much data as any other node during the sub-frame. What is the average transmission rate by the base station (to all nodes) during the subframe? Explain how you arrived at your answer. *Hint*, to calculate the average transmission rate for one node only is enough. [12]

2. (a) List and briefly explain two benefits of *network* virtualisation. [4]
- (b) Describe virtual bridges and virtual switches. [6]
- (c) One proposed solution to allow mobile users to maintain their IP addresses as they moved among foreign networks was to have a foreign network advertise a highly specific route to the mobile user and use the existing routing infrastructure to propagate this information throughout the network. We identified scalability as one concern. Suppose that when a mobile user moves from one network to another, the new foreign network advertises a specific route to the mobile user, and the old foreign network withdraws its route. Consider how routing information propagates in a distance-vector algorithm (particularly for the case of interdomain routing among networks that span the globe).
- (i) Will other routers be able to route datagrams immediately to the new foreign network as soon as the foreign network begins advertising its route? Explain. [6]
- (ii) Is it possible for different routers to believe that different foreign networks contain the mobile user? [6]
- (iii) Discuss the timescale over which other routers in the network will eventually learn the path to the mobile users. [3]
3. (a) Ethernet and wireless networks have some similarities and some differences. One property of Ethernet is that only one frame at a time can be transmitted on an Ethernet. Does 802.11 share this property with Ethernet? Discuss your answer. [8]
- (b) In wireless communications, assume all stations can hear all other stations. One station wants to transmit and senses the carrier idle. Why can a collision still occur after the start of transmission? [7]
- (c) What are the main problems when transmitting data using wireless systems that were made for voice transmission? What are the possible steps to mitigate the problems and to raise efficiency? How can this be supported by billing? [10]

SECTION B – Answer TWO questions.

4. (a) In modern operating systems, active processes move through a range of different states during their lifecycle, briefly explain the condition(s) under which the OS moves a process from:

- (i) The New state to the Ready state. [2]
- (ii) The Running state to the Waiting state. [2]

- (b) Consider the following set of processes with arrival times and length of CPU burst times given in milliseconds:

Process	Arrival time	No. bursts
P1	0	6
P2	1	8
P3	3	2
P4	5	5

Which CPU scheduling algorithm listed below yields the shortest average turnaround time? [13]

- (i) FCFS (First-Come-First-Served)
- (ii) SJF (Shortest Job First; **without pre-emption**)
- (iii) SRT (Shortest Remaining Time; same as SJF with **pre-emption**)

- (c) What is meant by a fault tolerant system? [2]

- (d) In fault tolerant systems, a process that exhibits a failure has to be able to recover to a correct state. What are the two basic types of recovery? Briefly explain each of them. [6]

5. (a) Concurrency refers to any form of interaction among threads and processes such as sharing of, and competition for system resources.
- (i) Briefly explain the terms “race condition” and “critical section”. [4]
- (ii) Consider the pseudocode below of two threads A and B that share the variable “counter”. Define a possible execution scenario that leads to a race condition. [6]

Thread A: counter++
register₁ = counter
register₁ = register₁ + 1
counter = register₁

Thread B: counter--
register₂ = counter
register₂ = register₂ - 1
counter = register₂

- (b) Cloud computing, often referred to as simply “the cloud,” is the delivery of on-demand computing resources — everything from applications to data centers — over the internet on a pay-for-use basis.
- (i) Outline three benefits of cloud computing and two of its main drawbacks. [5]
- (ii) List four of the essential characteristics of cloud computing. [4]
- Briefly explain one of these characteristics and give an example of how it might apply in practice. [6]

6. (a) In the pseudocode below, three processes, P0, P1 and P2, are competing for six resources labelled A to F:

<pre> void P0() { while (true) { get(A); get(B); get(C); // critical section: // use A, B, C release(A); release(B); release(C); } } </pre>	<pre> void P1() { while (true) { get(B); get(D); get(E); // critical section: // use B, D, E release(B); release(D); release(E); } } </pre>	<pre> void P2() { while (true) { get(C); get(D); get(F); // critical section: // use C, D, F release(C); release(D); release(F); } } </pre>
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If we assume the scheduling scenario: P0-P1-P2-P0-P1-P2 (line by line), draw the corresponding Resource Allocation Graph (RAG). [4]

Is there any possibility of deadlock? Explain your answer. [4]

- (b) SUN Network File System (NFS) is an implementation and a specification of a software system for accessing remote files across LANs (or WANs).

(i) How remote file operations are handled in NFS? [2]

(ii) Does NFS V4 published in RFC 7530 use stateless or stateful servers? [2]

(iii) For both Andrew File System (AFS) and Network File System (NFS) the usage of a central server is considered as a scalability bottleneck (and single point of failure), explain how this issue is solved in Google File System (GFS) architecture. [5]

- (c) Virtualization technology enables a single PC or server to simultaneously run multiple operating systems or multiple sessions of a single OS.

(i) What are the different approaches used for virtualization? [4]

(ii) Explain how virtualization technology enable “higher utilisation rate” of the hardware infrastructure in cloud computing context. [4]

END