



ARAB OPEN UNIVERSITY
FACULTY OF COMPUTER STUDIES
INFORMATION TECHNOLOGY AND COMPUTING

T305: DIGITAL COMMUNICATION
FALL 2005/2006

PART I FINAL

IMPORTANT:

- 1) This exam has **4 parts** with a total of **48 questions** (30 in Part 1, 10 in Part 2, 7 in part 3 and 1 in Part 4).
- 2) **Part 1** questions carry a **WEIGHT OF 1 mark each**.
- 3) **Part 2** questions carry a **WEIGHT OF 2 marks each**.
- 4) **Part 3** questions carry a **WEIGHT OF 5 marks each**.
- 5) **Part 4** questions carry a **WEIGHT OF 15 marks each**.
- 6) The exam paper consists of 19 pages including this page.
- 7) Exam duration is 180 minutes.
- 8) Write your student ID, name, group number, and tutor name on this page **as well as on the last page of this exam**.
- 9) Fill in your answers in the Answer Area Provided on this Exam Paper. No paper will be graded if the answers are not filled.

معلومات هامة:

- 1) هذا الامتحان مكون من ثلاثة أجزاء، بمجموع (48) سؤالاً. (الجزء الأول يتكون من (30) سؤالاً، الجزء الثاني مكون من (10) أسئلة، الجزء الثالث مكون من (7) أسئلة و الجزء الرابع مكون من (1) سؤال).
- 2) كل سؤال في الجزء الأول له (1) علامة.
- 3) كل سؤال في الجزء الثاني له 2 علامات.
- 4) كل سؤال في الجزء الثالث له 5 علامات
- 5) السؤال في الجزء الرابع له 15 علامات.
- 6) عدد صفحات هذا الامتحان (19) صفحة من ضمنها هذه الصفحة.
- 7) مدة الامتحان (180) دقيقة.
- 8) أكتب رقمك الجامعي، واسمك، ورقم شعبتك، واسم المشرف الأكاديمي على هذه الصفحة وعلى صفحة الإجابة الأخيرة.
- 9) أجب على جميع الأسئلة في الأماكن المخصصة لذلك على نفس الورقة. لن تصحح أي ورقة ما لم تكن الإجابة في المكان المخصص.

Student ID:	Student Name:
Group Number:	Tutor Name:

Part I: Multiple Choice questions (30 marks)

This part consists of **30 questions** carrying a **WEIGHT OF 1 mark each**. You must answer **ALL** of the following **Multiple choice** questions by **circling the correct answer choice** for each question (**advised time about 45 minutes**).

- 1) The solution to the problem of _____ of the Internet is to break the network down into manageable parts, or domains each called Autonomous System.
 - a) high cost
 - b) scalability
 - c) interfaces
 - d) different protocols

- 2) The routing of packets among nodes within Autonomous System is carried out by the routers using a protocol called _____.
 - a) IGP
 - b) BGP
 - c) EGP
 - d) PGP

- 3) Routing between Autonomous Systems uses a different protocol called a _____.
 - a) BGB
 - b) PGP
 - c) BGP
 - d) PGB

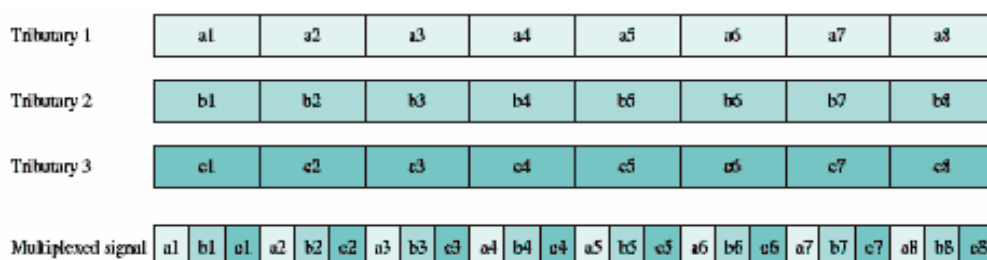
- 4) In an object-oriented model, one special type of relationship that exists between objects is when one object is part of another. This is called _____.
 - a) multiplicity
 - b) aggregation
 - c) containment
 - d) both b and c

- 5) In an object-oriented model, an object contains a collection of data items relating to a particular component of the system. They are called _____.
 - a) operations
 - b) services
 - c) attributes
 - d) methods

- 6) Source and destination port numbers, and sequence and acknowledge numbers are main fields that are defined inside _____.
 - a) a TCP segment
 - b) an IP segment

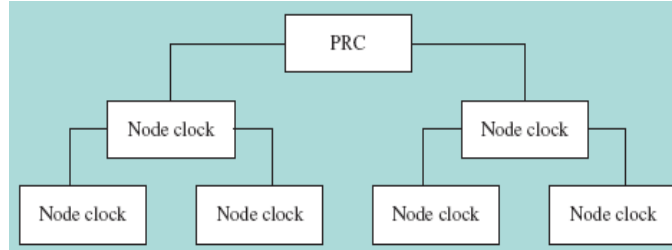
- c) an Ethernet segment
d) a MAC segment
- 7) In an attempt to improve the email service, a new protocol has been proposed as an extension for SMTP. This protocol is known as _____.
- a) ESMTP
b) MIME
c) MOME
d) MITP
- 8) In network environment, providing a reliable service is the main concern of _____.
- a) internet protocol
b) transmission control protocol
c) universal datagram protocol
d) Ethernet protocol
- 9) The main role of the _____ is to determine whether a request from the PC's operating system is for local or remote resource.
- a) NetBIOS
b) Redirector
c) Server Message Block
d) TCP/IP protocol stack
- 10) A key principle for digital transmission is _____.
- a) serial synchronization
b) frequency synchronization
c) frame synchronization
d) multiplexing synchronization

- 11) The figure below is an example of a time division multiplexing process that is based on _____.



- a) bit-interleaving
b) byte-interleaving
c) octet-interleaving
d) word-interleaving
- 12) One second period that contains 30% or more of errored blocks is called _____.
- a) severely errored second
b) highly errored second

- c) large errored second
 - d) huge errored second
- 13) The tree arrangement in the figure below shows how timing is distributed from the primary reference clock (PRC) to a series of slave clocks. This is an example of _____.



- a) Intra-station synchronization
 - b) Inter-station synchronization
 - c) Ultra-station synchronization
 - d) Multi-station synchronization
- 14) _____ is the standard defined by the ANSI T1 for synchronous operation used in North America.
- a) DCC
 - b) STM-1
 - c) ADM
 - d) SONET
- 15) The reliability function, $R(t)$, and failure function, $Q(t)$ that give the probability of something happening up to specified time are known as _____.
- a) probability density distribution
 - b) cumulative probability distribution
 - c) cumulative density distribution
 - d) normal probability distribution
- 16) _____ is that part of a network element which provides a home within the telecommunication system for the agent that will manage the network element.
- a) Q adaptor function block
 - b) Mediation function block
 - c) Reference function block
 - d) Network element function block
- 17) For simplifying network management, the ITU standards have divided the management domain into _____ layers.
- a) two
 - b) three
 - c) four
 - d) five

- 18) In telecommunication management network (TMN) system, the agent replies to the manager commands are known as _____.
- a) operations
 - b) feedbacks
 - c) notifications
 - d) acknowledges
- 19) The communication protocol, which is used to achieve communication between agents and managers is _____.
- a) TCP
 - b) FTP
 - c) CCNP
 - d) CMIP
- 20) For a communication system, the number of symbols used in the code alphabet is known as _____.
- a) radix
 - b) dot
 - c) dash
 - d) code word
- 21) The Shannon's noiseless coding theorem is based on _____.
- a) Shannon's first theorem
 - b) Shannon's second theorem
 - c) Shannon's third theorem
 - d) Shannon's fourth theorem
- 22) In a communication system, the failure of the reconstructed signal to follow the original one is known as _____.
- a) falling construction
 - b) falling slope
 - c) overload failure
 - d) slope overload
- 23) The main reason for adding headers in each layer of OSI model is _____.
- a) to identify which application is used
 - b) to identify performance and speed
 - c) to provide control information on how to handle data/packets
 - d) to show the user the order of responsibility of each layer
- 24) _____ is used to ensure that the sender does not overwhelm the receiver.
- a) Data control
 - b) Send control
 - c) Receive control
 - d) Flow control

- 25) For a message of 50 frames using stop-and-wait flow control, _____ acknowledgments would be returned to the sender.
- a) none
 - b) 1
 - c) 50
 - d) medium dependable
- 26) _____ is the most powerful error-detection method.
- a) Parity
 - b) Longitudinal redundancy checking
 - c) Checksum checking
 - d) Cyclic redundancy checking
- 27) _____ data link protocol uses start and stop bits.
- a) Asynchronous
 - b) Synchronous
 - c) Full duplex
 - d) Simplex
- 28) A point-to-point circuit can be _____.
- a) half-duplex
 - b) full-duplex
 - c) either a or b
 - d) neither a nor b
- 29) At _____ layer, physical addressing occurs.
- a) physical
 - b) data link
 - c) network
 - d) application
- 30) A sender must _____ before a sender's sliding windows buffer can expand.
- a) send an acknowledgment
 - b) receive an acknowledgment
 - c) either a or b
 - d) neither a nor b

Part II: Short essay questions (20 marks)

This part consists of **12 questions** carrying a **WEIGHT OF 2 marks each**. You must answer **only 10 (any)** of the following questions **using the space provided below on this exam paper** (advised time about 45 minutes).

31) What are deterministic finite state machines?

32) State, only three steps, which are necessary in building an objected oriented model of a system.

33) What is the Sliding Window Algorithm?

34) Define the pulse code modulation PCM process.

35) In digital communication, what do we mean by jitter (brief explanation)?

36) State the minimum functions that are necessary for the telecommunication network management (TMN) to have in order to manage a simple network.

37) For a communication system, define the term Entropy.

38) What is meant by Hamming distance?

39) Explain briefly what is meant by multiplex mountain problem in PDH and how can this be avoided in the SDH?

40) What is the use of management information base (MIB).

41) Describe the 3-packet handshake mechanism of TCP connection establishment.

42) Briefly describe MAC sublayer and why it is used.

Part III: Numerical problems (35 marks)

This part consists of **10 questions** carrying a **WEIGHT OF 5 marks each**. You must answer **only 7 (any)** of the following questions **using the space provided below on this exam paper** (advised time about 60 minutes).

- 43) A network contains 6 routers. Each has a probability of 0.98 of being in operation at any given time.
- a) What is the probability of all the routers being out of operation?
 - b) What is the probability of 3 of them being out of operation?

Solution:

- 44) The table below gives values for the reliability function $R(t)$ at 1000-hour intervals from the beginning of a test on 6000 components. Estimate the number of components failing between 3250 and 3750 hours?

Solution:

Time (hours)	Reliability value
0	1.0
1000	0.9600
2000	0.9216
3000	0.8848
4000	0.8494
5000	0.8154

45) A batch of components, which has already been through burn-in, is found to have a constant hazard rate of 0.02 per day. If the size of the batch is 1000, how many components are likely to be in operation:

- a) after the first day of the test?
- b) after the third day?
- c) after 12 days?

Solution:

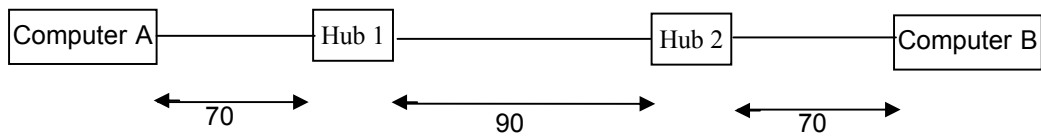
46) The table shown below shows the results from the first 6 days of a test of 10,000 components, which have already been through burn-in.

- a) Give an approximate value for the constant hazard rate of this batch of components.
- b) Using your result, predict how many components will still be operating at the beginning of day 13.

Day	Failures during day
1	181
2	177
3	173
4	171
5	166
6	160

Solution:

47) What is the round trip delay between two computers, A and B connected as shown in the figure below?



Assume the following:

- Operation at 10 Mbit/s.
- Velocity of propagation through the cable is 1.77×10^8 m/s.
- Delay through each repeater is $1 \mu\text{s}$.

Solution:

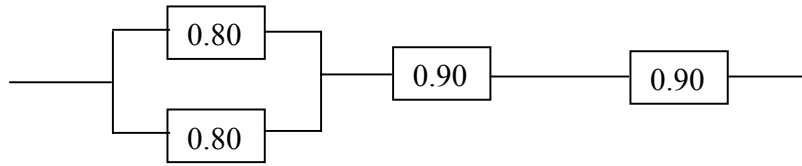
48) A BIP-8 calculation is carried out on the following block of data:

10011110 11110111 10100001 01100101 10111100 11010110

Determine the value of the BIP bits, assuming even parity?

Solution:

49) A subsystem of a communication system has the reliability diagram shown in the figure below that shows the individual components reliability.



Calculate the overall reliability of the system to two significant figures.

Solution:

50) There are eight symbols, a to h, in a source alphabet. Table below lists the probabilities of occurrence of each symbol.

Determine the entropy of the source to two significant figures.

Solution:

Source symbol	Probability of occurrence
a	0.40
b	0.25
c	0.15
d	0.08
e	0.06
f	0.03
g	0.02
h	0.01

51) Four-digit binary words are transmitted using the 7-digit Hamming code. The 7-bit word 1101100 is received, where the right hand bit corresponds to digit number 7.

Determine the original 4-bit word that was transmitted assuming only a single or no error occurred.
(Assume even parity)

Solution:

52) A channel can be modeled as having a bandwidth of 3.6 kHz can be operated at 50% of its theoretical capacity.

Determine the minimum Signal-to-Noise (SNR) that can be tolerated if the transmission rate of 7.8 Kbit/s is to be achieved. (N.B: $\log(20)=1.3$)

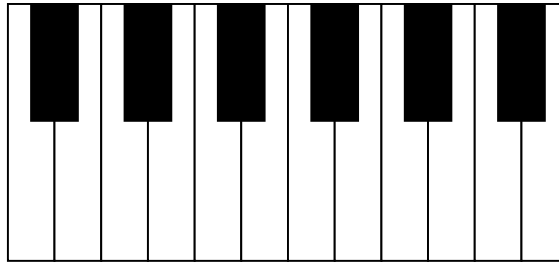
Solution:

Part IV: Typical problems (15 marks)

This part consists of **2 questions** carrying a **WEIGHT OF 15 marks each**. You must answer **only 1 (any)** of the following questions **using the space provided below on this exam paper** (advised time about 30 minutes).

- 53) A children's multimedia package contains a simple application for creating music, based on the keyboard shown in the figure below.

A simple keyboard



Children can create their own music by clicking with the mouse on the different keys. The software represents each note of the music according to which key was clicked, and in this simple application each note has the same duration.

- How many binary digits are needed to represent a note of the music using a fixed-length code?
- Assuming that the children are equally likely to click on any key, what is the entropy of the system?
- What is the efficiency of the code?

The developers of the software carry out some testing with children, and find that the children click on the white keys much more often than on the black keys. In a test of 1500 mouse clicks, a child clicks, on average, 150 times on each of the white keys and 36 times on each of the black keys.

Based on this test data, give updated values for:

- the entropy of the system, and
- the efficiency of the code.

Solution:

54) A space mission to Mars is recording data about the planet's surface, and sending the data back to scientists on earth for analysis. The experimental data consists of measurements, given to the nearest centimeter, of how far a probe is able to penetrate the surface. Scientists have predicted that the surface of the region under test will be similar to a certain region on earth, for which they already have penetration data. This data is given in the table below where the first column gives the penetration depth (to the nearest centimeter) and the second column gives the relative frequency of this outcome.

Penetration depth (cm)	Relative frequency
0	0.4
1	0.25
2	0.15
3	0.11
4	0.05
5	0.04

The communication link has a low data rate, so a very efficient coding must be used for the transmission. A Huffman code is therefore used, based on the data in the table above.

- Give a possible set of code words for the different penetration depths.
- If a penetration test is carried out every 6 seconds, and the Mars data is similar to the earth data, how many binary digits need to be transmitted, on average, in 2 hours of testing?
- How much information (in bits) is generated, on average, in 2 hours of testing?
- What is the efficiency of the code?

Solution:

Student ID:	Student Name:
Group Number:	Tutor Name:

GRADING AREA: FOR TUTOR USE ONLY

Part 1	
Total Number of Correct Answers	Marks Awarded
	1 *Total Number of Correct Answers =

Part 2	
Question Number	Marks Awarded (only 10 out of 12)
Q31 (out of 2 marks)	
Q32 (out of 2 marks)	
Q33 (out of 2 marks)	
Q34 (out of 2 marks)	
Q35 (out of 2 marks)	
Q36 (out of 2 marks)	
Q37 (out of 2 marks)	
Q38 (out of 2 marks)	
Q39 (out of 2 marks)	
Q40 (out of 2 marks)	
Q41 (out of 2 marks)	
Q42 (out of 2 marks)	
Total marks for Part 2 (out of 20 marks)	

Part 3	
Question Number	Marks Awarded (only 7 out of 10)
Q43 (out of 5 marks)	
Q44 (out of 5 marks)	
Q45 (out of 5 marks)	
Q46 (out of 5 marks)	
Q47 (out of 5 marks)	
Q48 (out of 5 marks)	
Q49 (out of 5 marks)	
Q50 (out of 5 marks)	
Q51 (out of 5 marks)	
Q52 (out of 5 marks)	
Total marks for Part 3 (out of 35)	

Part 4	
Question Number	Marks Awarded (only 1 out of 2)
Q53 (out of 15 marks)	
Q54 (out of 15 marks)	

SEMESTER GRADE = ((Part 1 + Part 2 + Part 3+ part 4) /4) =	
---	--