

## Degree Examination in EG 4546 Communications Engineering

## SAMPLE PAPER

**Notes:** (i) CANDIDATES ARE PERMITTED TO USE APPROVED CALCULATORS  
(ii) CANDIDATES ARE NOT PERMITTED TO USE THE ENGINEERING MATHEMATICS HANDBOOK  
(iii) AN INFORMATION SHEET OF PROTOCOL HEADERS IS PROVIDED

## PLEASE NOTE THE FOLLOWING

- (i) You **must not** have in your possession any material other than that expressly permitted in the rules appropriate to this examination. Where this is permitted, such material **must not** be amended, annotated or modified in any way.
- (ii) You **must not** have in your possession any material that could be determined as giving you an advantage in the examination.
- (iii) You **must not** attempt to communicate with any candidate during the exam, either orally or by passing written material, or by showing material to another candidate, nor must you attempt to view another candidate's work.

**Failure to comply with the above will be regarded as cheating and may lead to disciplinary action as indicated in the Academic Quality Handbook**  
([www.abdn.ac.uk/registry/quality/appendix7x1.pdf](http://www.abdn.ac.uk/registry/quality/appendix7x1.pdf)) Section 4.14 and 5.

Candidates should attempt FIVE questions. All questions carry 20 marks.

1. (a) Explain how a system is assigned a *Medium Access Control* (MAC) address for use on an Ethernet *Local Area Network* (LAN). [4 marks]
- (b) *Ethernet addresses* are sometimes described as belonging to a "*Flat Address Space*". What does this mean? [4 marks]
- (c) Describe the process of *Manchester Encoding*, explaining why this was introduced and illustrate your answer by sketching the waveforms when the following sequence of binary data is transmitted over 10BT cabling: {0 0 1 1 0}. [6 marks]
- (d) Sketch the *Ethernet Preamble* waveform and explain the purpose of the *Ethernet Preamble* at the start of each frame. [6 marks]

*continued over*

2. (a) Describe the *carrier sense multiple access algorithm*. [8 marks]
- (b) How did the *Fast Ethernet* standard overcome the bandwidth constraint of *Unshielded Twisted Pair (UTP)* cabling to allow transmission at 100 Mbps? [8 marks]
- (c) In the context of *Fast Ethernet* explain and provide appropriate diagrams to show how the sequence of bits {1 0 0 1 1 0 } are encoded for transmission. [4 marks]

3. (a)

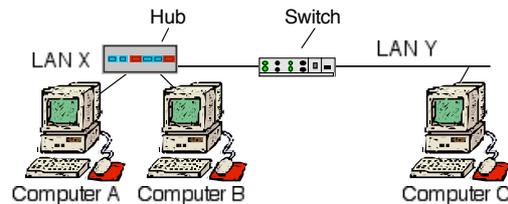


Figure 1: Connecting Ethernet Local Area Networks (LANs)

Describe the operation of a switch. Illustrate your answer by showing how the switch in figure 1 (above) uses address learning to determine whether frames from computer A are to be forwarded from LAN X to LAN Y. [8 marks]

- (b) Why should simple (unmanaged) Ethernet switches not be connected in a “loop”? [2 marks]

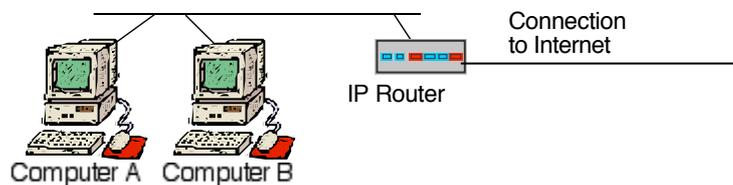


Figure 2: Computers A and B connected via a Local Area Network to the Internet

- (c) Use the LAN shown in Figure 2 to explain the process by which computer A determines whether or not to use the IP router to communicate with a specific IP address. [5 marks]
- (d) Identify the protocol layers associated with *each* of the following three protocols:  
*User Datagram Protocol (UDP)*,  
*Carrier Sense Multiple Access (CSMA/CD) protocol*,  
*Internet Protocol (IP)*. [3 marks]
- (e) IP is specified as a *Best Effort* service. What does this term mean? [2 marks]

*continued over*

4. (a) The *User Datagram Protocol (UDP)* is a simple transport protocol supported by the *Internet Protocol (IP)* suite. Explain the function of each of the headers used by the UDP transport protocol. [4 marks]

(b) How does the *Domain Name Service (DNS)* resolver in the network stack use a remote DNS server to resolve the *name* that corresponds to a specific *IP network address*? [9 marks]

(c) The figure below show the first few bytes of a frame captured using a network monitor:

```
00e0 f726 3fe9 0800 2086 354b 0800 4500 ...
```

*Figure 3: Captured Ethernet Frame*

- (i) What is the Ethernet destination address? [2 marks]
- (ii) Is this a multicast frame? [1 mark]
- (iii) The interface was set to *promiscuous mode*, what does this mean? [3 marks]
- (iv) What sort of packet is contained in the frame payload? [1 mark]

5. (a) The figure below show the first few bytes of a frame captured using a network monitor:

```
001a 2f18 9790 001e c2be 4c73 0800 45c0 0028 d0b5
0000 ff06 c184 0a0a 0a01 0a0a 0ac1 0017 c059 4435
64b2 404b becb 5010 0fdf 0eb1 0000 0000 0000 0000 ...
```

*Figure 4: Captured Ethernet Frame*

Explain how this frame may be decoded to find the *Service Access Point* added by each protocol layer, and hence determine the set of protocols that were used. [5 marks]

(b) An *End System* uses the “*ping*” program to send an *Internet Control message Protocol echo-request* message with a payload of 100 Bytes. What is the total size of the Ethernet frame that is sent (including the preamble)? [5 marks]

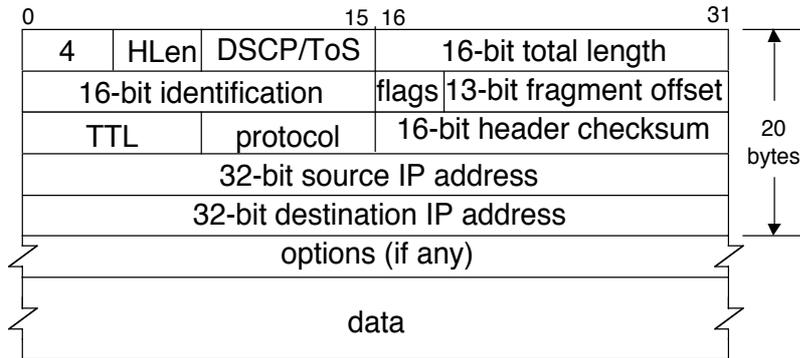
(c) Provide diagrams and a detailed explanation on *either* of the two following topics:

Explain how the *traceroute* program may be used to determine if an Internet path is operating correctly. Your answer should include relevant diagrams to explain the sequence of packets that are sent by *traceroute*. [10 marks]

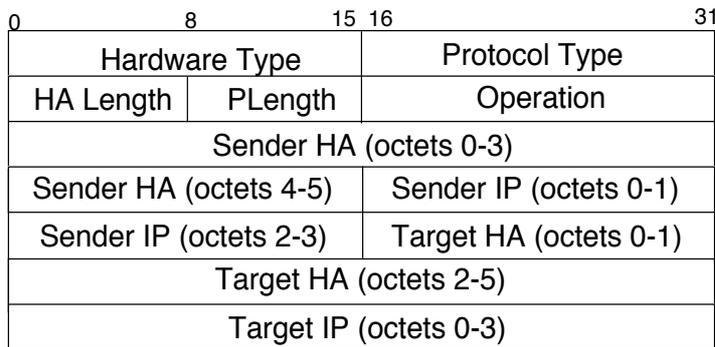
**or**

Explain how an IP host using Ethernet can automatically determine the Medium Access Control address for another IP host connected to the same Ethernet broadcast domain. Your answer should include relevant diagrams to illustrate how this works when three consecutive packets are sent to a new host that has just been added to the Ethernet network. [10 marks]

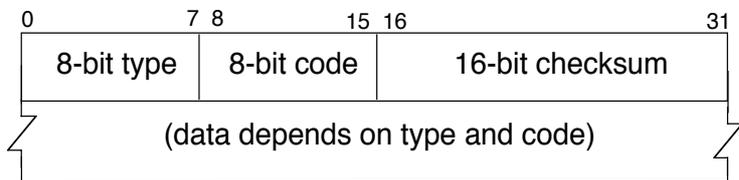
## PDU Header Chart



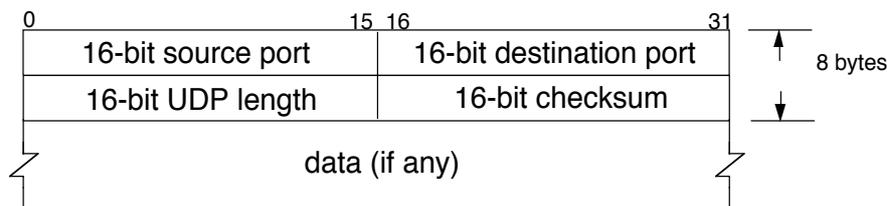
### Internet Protocol Datagram (Ethernet Type = 0x800)



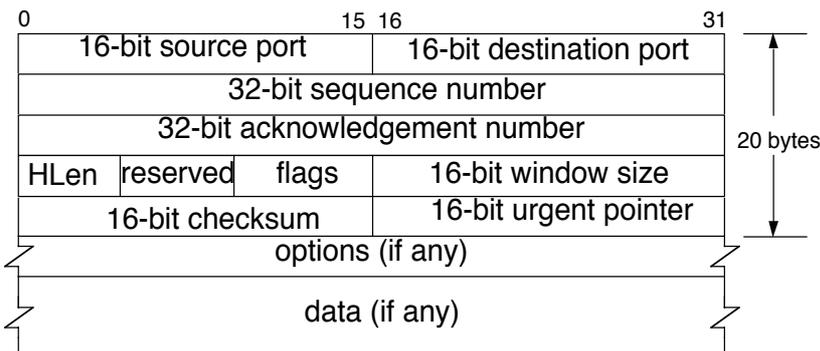
### ARP / RARP Packet (Ethernet Type = 0x806)



### ICMP Message



### UDP Packet



### TCP Packet

### IP Protocol Types

0	IP
1	ICMP
2	IGMP
6	TCP
17	UDP

### IPv4 Flags

--X	More
-X-	Don't Fragment
X--	Unused

### IPv4 DSCP/ToS

XXXXXX	-- DSCP Value
-----00	Discard in congestion
-----01	ECN enabled (A)
-----10	ECN enabled (B)
-----11	Congestion indication

### Operation ARP Message

1	ARP request
2	ARP reply
3	RARP request
4	RARP reply

### ICMP Message

Type	Message
0	Echo reply
3	Destination unreachable (also used by PMTUD)
4	Source quench
5	Redirect
8	Echo request

### Well-Known TCP/UDP Server Ports

Port (decimal)	Service
23	Telnet
25	Mail
69	TFTP
80	WWW (http)