Module 17 Networks & Data Communications

Module title	Networks & Data Communications
Module NFQ level (only if an NFQ level can be demonstrated)	7
Module number/reference	BSCH-NDA
Parent programme(s)	Bachelor of Science (Honours) in Computing Science
Stage of parent programme	Award Stage
Semester (semester1/semester2 if applicable)	Semester 1
Module credit units (FET/HET/ECTS)	ECTS
Module credit number of units	10
List the teaching and learning modes	Direct, Blended
Entry requirements (statement of knowledge, skill and competence)	Learners must have achieved programme entry requirements.
Pre-requisite module titles	BSCH-CH, BSCH-OSD
Co-requisite module titles	None
Is this a capstone module? (Yes or No)	No
Specification of the qualifications (academic, pedagogical and professional/occupational) and experience required of staff (staff includes workplace personnel who are responsible for learners such as apprentices, trainees and learners in clinical placements)	Qualified to as least a Bachelor of Science (Honours) level in Computer Science or equivalent and with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.
Maximum number of learners per centre (or instance of the module)	60
Duration of the module	One Academic Semester, 12 weeks teaching
Average (over the duration of the module) of the contact hours per week	4
Module-specific physical resources and support required per centre (or instance of the module)	One class room with capacity for 60 learners along with one small class room with capacity for 25 learners for each group of 25 learners

Analysis of required learning effort		
	Minimum ratio teacher / learner	**Hours**
Effort while in contact with staff		
Classroom and demonstrations	1:60	36
Monitoring and small-group teaching	1:25	12
Other (specify)		
Independent Learning		
Directed e-learning		
Independent Learning		90
Other hours (worksheets and assignments)		112
Work-based learning – learning effort		
Total Effort		250

Allocation of marks (within the module)					
	Continuous assessment	**Supervised project**	**Proctored practical examination**	**Proctored written examination**	**Total**
Percentage contribution	50%			50%	100%

Module aims and objectives

This module provides the learner with a detailed understanding and appreciation of communication networks layouts and a wide range of networking standards and protocols. The module concentrates on the physical layer, signalling and signal encoding schemes and the datalink layer. This module also covers higher level network protcols which enhance knowledge about communication in networks. It also provides a basic understanding of wireless networks.

Minimum intended module learning outcomes

On successful completion of this module, the learner will be able to:

1. Explain basic network concepts and the ISO/OSI and TCP/IP reference models.
2. Discuss network connectivity, topologies, data switching techniques and concepts of media access control
3. Discuss analog and digital signals and signaling, as well as encoding techniques and signal impairments.
4. Explain in detail two of the data link layer functions, framing, error detection techniques
5. Discuss basic concepts of routing for data through data networks
6. Explain IP/TCP protocols and the IP addressing scheme
7. Illustrate a simple communication system functionality or protocol

Rationale for inclusion of the module in the programme and its contribution to the overall MIPLOs

Data communication and networking are fundamental to all modern communication in computing science. Without these there is no internet, no Web, and no ability to develop systems that communicate with each other. Knowledge of these areas is essential to anyone who wants to work in the IT industry. Appendix 1 of the programme document maps MIPLOs to the modules through which they are delivered.

Information provided to learners about the module

Learners receive a programme handbook to include module descriptor, module learning outcomes (MIMLO), class plan, assignment briefs, assessment strategy and reading materials.

Module content, organisation and structure

Introduction to networks

- Topologies
- Media: twisted pair, co-axial, fiber optic, satellites
- Network devices: repeaters, hubs, bridges, switches, routers etc.
- ISO-OSI Reference model and the IP/TCP model
- IP addressing, masks

Signals and signal impairment:

- Digital & analogue signals, frequencies, capacity, bandwidth
- Digitizing analogue signals
- Multiplexing & demultiplexing
- Signal impairment: Noise, Attenuation, distortion
- Simplex, half duplex and full duplex
- Amplitude, Frequency and phase shift Modulation. Waveforms

Encoding schemes:

- NRZ-I, NRZ-L, Manchester, Bipolar AMI encoding, multilevel and two level binary schemes
- Encoding techniques for: Analogue data over an analogue medium and Analogue data over a digital medium
- Encoding techniques for: Digital data over an analogue medium and Digital data over a digital medium
- Encoding analogue signal into a digital signal
- Linear encoding, negative effects, alternative approaches

Maximum channel Capacity:

- Capacity of a channel, signal levels
- Nyquist and Shannon formulas for maximum channel capacity

Switching techniques:

- Datagram, circuit and virtual circuit switching techniques
- Operations, packets movements and routing, channel utilization, headers contents, data size, advantages, and disadvantages, performance
- Permanent Virtual circuits.

Basic datalink and network layer functions

- Framing: flags, Bit stuffing/unstuffing
- Error detection systems: Parity bit, block parity and CRC
- Media access protocols: TDM, Token, Polling, CSMA, CSMA/CD
- Introduction to routing. Fixed routing

LANs services

- Emails,
- Simple Mail Transport Protocol (SMTP)
- Post Office Protocol POP
- Internet Message Access Protocol (IMAP)
- Multipurpose Internet Mail Extensions or MIME

Module teaching and learning (including formative assessment) strategy

The module is delivered through a combination of lectures, tutorials and practical lab sessions. The tutorials and practical lab sessions reinforce the learning in lectures. The emphasis is on developing knowledge and understanding in context. Learners learn how to build a network through manufacturing cables, building a local area network using a switch, configuring and troubleshooting the network in the faculty hardware lab.

Assessment is divided into four elements. The continuous assessment consists of a series of tutorials, a take home assessment, and a mid-term class test. These assess the learner's competency in specific areas of the syllabus. Finally, there is an end of semester exam that tests the learners understanding of the theoretical material.

Timetabling, learner effort and credit

The module is timetabled as one 3-hour lecture per week and one 1-hour practical session per week.

Continuous assessment spreads the learner effort to focus on small steps and helps to ensure learner engagement over the course of the module.

There are 48 contact hours made up of 12 lectures and 12 practical sessions delivered over 12 weeks with both taking place in a classroom. The learner will need 90 hours of independent effort to further develop the skills and knowledge. gained

through the contact hours. An additional 112 hours are set aside for learners to work on class tests that must be completed for the module.

The team believes that 250 hours of learner effort are required by learners to achieve the MIMLOs and justify the award of 10 ECTS credits at this stage of the programme.

Work-based learning and practice-placement
There is no work based learning or practice placement involved in the module.

E-learning
The college VLE is used to disseminate notes, advice, and online resources to support the learners. The learners are also given access to Lynda.com as a resource for reference.

Module physical resource requirements
Requirements are for a classroom for 60 learners equipped with a projector.

Reading lists and other information resources
Recommended Text
Kurose, J. F. and Ross, K. W. (2017) *Computer Networking: a top-down approach*. Boston: Pearson.

Stallings, W. (2013) *Data and Computer Communications*. Boston: Pearson Education.

Secondary reading
Comer, D. E. (2014) *Computer Networks and Internets*. Boston: Pearson Education Limited.

Specifications for module staffing requirements
For each instance of the module, one lecturer qualified to at least Bachelor of Science (Honours) in Computer Science or equivalent, and with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.. Industry experience would be a benefit but is not a requirement.

Learners also benefit from the support of the programme director, programme administrator, learner representative and the Student Union and Counselling Service.

Module Assessment Strategy

The assignments constitute the overall grade achieved, and are based on each individual learner's work. The continuous assessments provide for ongoing feedback to the learner and relates to the module curriculum.

No.	Description	MIMLOs	Weighting
1	Tutorials: aims at enhancing the understanding of module material covered	1-7	15%
2	Assignment: a programming or a technical report relevant to some topic in networks.	7	15%
3	A mid-term test.	2, 3	20%
4	Written exam that tests the theoretical aspects of the module	1-7	50%

All repeat work is capped at 40%.

Sample assessment materials

Note: All assignment briefs are subject to change in order to maintain current content.

Networks and Data Communications
Tutorial 01 – Introduction – NWs, Models & devices

1) List the seven layers of the Reference model.
2) Match the following functions to one or more layers of OSI/RM model:

   a. Route determination
   b. Flow control
   c. Providing access for the end user for transferring of files
   d. Packet switching
   e. Establishing virtual channels and terminating them
   f. Transmission of bits
   g. Bit stuffing
   h. Monitoring congestion

3) With reference to the ISO-OSI Reference Model, explain the following:

   a. A protocol
   b. An Interface
   c. Access Service points
   d. Virtual communication

4) With reference to the ISO-OSI Reference Model, what is meant by encapsulation?

5) What is the difference between a node-to-node and an end-to-end communication?

6) Compare the functions, level of operation and intelligence of the following network devices:
   A router, a bridge, a repeater, a hub and a switch
7) What is the Spanning Tree Protocol? Why is it used on Local Area Networks? Draw a diagram and explain how it works.

Networks and Data Communications
Tutorial 02 –Topologies

1) What advantages does a circuit-switched network have over a packet switched (datagram) network and vice versa?

2)
   a) What is point-to-point and multipoint connection?
   b) Give example of network topologies using point-to-point connections

3) With reference to a network, what is: capacity, performance, reliability, security, transit time and response time?

4) What is an internet, the Internet and an Intranet?

5) Name a topology where collisions can take place. What are the advantages of this topology?

6) Give four advantages and four disadvantages of ring topology. (give a simple reason for each)

7) What are the advantages of point-to-point over multipoint connectivity? And what are advantages of multipoint over point-to-point connectivity?

8) Describe the star topology and point out its advantages (use a diagram).

9) Is it better to have error detection at each node or to have error detection done once at end node?

Networks and Data Communications
Tutorial 03 – Media & Media access

1) List two disadvantage and five advantages of optical fiber over twisted pair cables and

2) Why are headers needed according to the reference model?

3) Consider the fiber optics and satellites communication media. Security during communication is one requirement to consider for media choice. Both when high level or low level of security is needed.

   State seven requirements that will influence your choice of media; For each high or low levels of each requirement give the choice of media that you recommend and the reasons for that choice, i.e. security, cost, noise, attenuation, bandwidth, terrain, distance, setup time etc.

5) List seven disadvantages and seven advantages of twisted pair over optical fiber cables.

6) Explain Token passing in media access, and write four advantages and four disadvantages.

7)
   (i) What is the CSMA/CD protocol?

   (ii) List the steps involved in the CSMA/CD.

   (iii) Explain the advantage of CSMA/CD over CSMA protocol.

   (iv) In CSMA, explain the terms persistent wait and non-persistent wait.

Networks and Data Communications
Tutorial 04 - Signals & signal impairment

1. Describe attenuation, delay distortion types of signal impairment, and explain the effects of each type.
2. Is distortion a more severe problem than attenuation? Can the two be related? Discuss.
3. State whether the following statement is right or wrong and explain why:

   “A fibre optic cable is a lot cheaper to use as a medium than a satellite”.
4. Discuss the reasons underlying the move by the major telecommunications carriers from copper wire to fiber optic media.
5. Explain clearly, how an analog signal differs from a digital signal. Use diagrams to illustrate your answer.
6. Explain what is meant by the bandwidth of a signal.

Networks and Data Communications
Tutorial 05 - Encoding Schemes

Q1) Show using a diagram the result of encoding the data 1 0 0 1 0 1 1 0 using the Unipolar and the BiPolar encoding schemes.

Q2) Show using a diagram the result of encoding the data 1 0 1 0 0 1 1 0 1 0 1 using the Manchester encoding schemes.

Q3) Show using a diagram the result of encoding the data 1 0 1 1 0 0 1 0 1 using the Manchester encoding scheme and show the data and clock signals.

Q4) For the bit pattern 10101010100, draw the electrical signal waveforms for NRZ-I and NRZ-L encoding schemes.

Q5) For the bit pattern 10101010110, draw the electrical signal waveforms for the Manchester encoding scheme.

Q6) For the bit pattern 10101010100, draw the waveforms for Bipolar AMI and Manchester encoding schemes.

Q7) For the bit pattern 1000110110, draw the waveforms for Pseudo-Ternary encoding schemes.

Q8) For the bit pattern 1010111, draw the waveforms for Manchester and Differential Manchester encoding schemes.

Networks and Data Communications
Tutorial 06 – Channel capacity

1) A channel uses the bandwidth between 2MHz and 6MHz. The signal to noise ratio is 30dB. What is the maximum theoretical data rate of the channel?

2) Assume that a channel uses a spectrum a frequencies between 2MHz and 4Mhz. The medium is subject to noise of 32dB. What is the maximum theoretical capacity of the channel? And how many signalling levels would be required in order to achieve this maximum value?
3) The power of a received signal is measured at 5mW (milliwatts). The SNR is 25dB. What is the power of the noise?

4) A channel uses the bandwidth between 5MHz and 6Mhz. The signal to noise ratio is 35dB. What is the maximum theoretical data rate of the channel?

5) A channel uses the bandwidth between 4MHz and 6Mhz. The signal to noise ratio is 30dB. What is the maximum theoretical data rate of the channel?

6) The power of a received signal is measured at 10mW (milliwatts). The SNR is 25dB. What is the power of the noise?

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Networks and Data Communications
Tutorial 07 – Wireless and Network Services

1) Explain the hidden nodes problem in wireless networks and what problems does it cause?

2) Explain advantages of MIME (Multipurpose Internet Mail Extensions) over other mail protocols.

3) Explain the email handling system architecture.

4) Explain: 1. 'ping' utility, and 2. 'ipconfig' Utility.

5) Explain advantages and disadvantages of wireless networks (wifi).

6) The IEEE802.11a wireless network standard operates in a different frequency band to the IEEE802.11b standard. In the context of the different frequency band used, is there any advantage to be gained from implementing the IEEE802.11a standard in preference to the IEEE802.11b standard?

7) What are the differences in operation between ARP (Address Resolution Protocol) and Reverse ARP?

Networks and Data Communications
Tutorial 08 – Error detection

(1) Show the new message to be sent by a sender after performing the CRC calculation using the generator X^3+1 on the message: 101110110.

(2) CRC error detecting code: Given the message M = 1010001101, determine the CRC using the generator polynomial $P=x^5+x^4+x^2+1$.

a) Show the polynomial key; calculate the CRC and the message to be transmitted.

b) How does the receiver check whether the message T was transmitted without any errors? Show that a transmission error (a bit change in the message) shall be discovered.

(3) This is a received message: 101110110101 which includes the frame check sequence calculated by CRC using the generator: X^3+1. As a receiver find out whether the message contains any errors.

(4) What are the advantages and disadvantages of Hamming code.

(5) This message 11001100 needs to be send after applying 4 parity even Hamming code. Show the full message to be sent.

(6) How much redundant information does the basic parity bit error check carries?

(7) The message 11001101 10101000 10111010 was received. For each of the methods below, show whether the message contains any errors.

(i) Using Odd Parity Bit error detection.

(ii) Using the Block Parity check with odd rows and columns, and the last byte considered a parity byte.

Networks and Data Communications
Tutorial 09 – Switching techniques & Fixed Routing

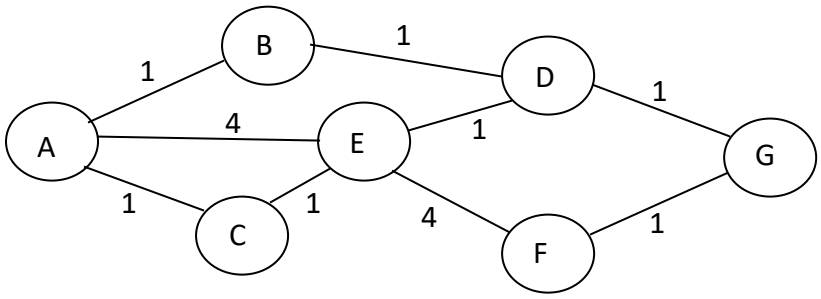
(1) Give four advantages and four disadvantages of datagram switching when compared with the circuit switching technique.

(2) If data is available to send, and both datagram and circuit switching techniques are available, which technique would you recommend to use in order to send data quicker? Justify your answer.

(3) How does the Virtual Circuit switching technique provide Quality of Service while the Datagram switching technique does not?

(4) Describe the datagram switching technique using ten statements.

(5) Consider the network in the following diagram with routers A to G. Produce the routing table for router E showing next nodes and lowest costs.



(6) Explain the shortest route algorithm.

BACHELOR OF SCIENCE IN COMPUTING SCIENCE

STAGE III

Class Test

NETWORKS & DATA COMMUNICATIONS

Lecturer:

This is a closed book, 60 minute test

This Class Test is worth 20% of the overall marks for the module.

ALL QUESTIONS TO BE ATTEMPTED.
ALL QUESTIONS CARRY EQUAL MARKS.

Answer all questions.

(1) Explain the Pulse Amplitude Modulation (PAM) and Pulse Code Modulation (PCM) processes in a digitization operation.

(2) Explain the purpose and idea of the scrambling operation employed in digital data encoding.

(3) Draw two diagrams showing the NRZL and NRZI encoding for the bit stream: 01001100011.

(4) Give five advantages and five disadvantages of the datagram switching technique over virtual circuit switching technique.

(5) What is the wavelength for light in nanometre (one billionth of a meter $1/10^9$) with frequency of 487×1014 Hz?

(Consider speed of light is 3×10^8 m/s)

(6) Give five conditions where a fibre optic is better to use than a satellite medium and explain why.

BSc3 Networks and Data Communications
Literature Survey and Report
Assignment (15%)

Investigate and study the topic allocated to you from the list below. A different topic may be suggested and may be used **if and only if approved** by your lecturer. Then write a comprehensive report about your investigation. Your study should not be general in nature but must concentrate on a specific aspect of the topic area. In relation to the topic and according to the relevance many aspects like performance, efficiency, design, implementations, algorithms, comparisons and operations may be covered. Your report should not exceed 7 pages and must not be less than 5 pages when printed using standard A4 papers and fonts no larger than 14 and no smaller than 10 points. But don't print it on paper.

The report must be submitted electronically as an MS DOC Word Document file. If you cannot make submission in this format then talk to the lecturer. The file must be uploaded into the module page on Moodle.

The first page of the report must include the following:

1. A suitable title for the report,
2. Your Student no.
3. Clearly and separately indicating your first name and family name
4. The course: in this case it should be (BSc3-Networks and Data Communication).
5. Please have the pages of your report numbered.

Please refer to recommended text books for the course. References can also be made from any books, journals, papers or reputable Websites.

The report must include the following 5 parts:

1) A brief abstract at the start. The abstract outlines what the report is about and the motivation for the study
2) An introduction providing a general discussion of the topic area describing the topic area and its relevance to the area of networks and communications
3) A detailed discussion of the relevant area of the topic.
4) A report summary at the end.
5) A list of references to sources of materials used. The reference list must be clearly indicated and can be from papers, books, technical reports, journals or reputable Internet websites.

The report must also include some drawings, or charts, or diagrams or case studies or examples in order to help clarify the ideas discussed.

Marks will be assigned as follows:

1) A brief abstract of the report outlining what the report is about and the motivation for the study. **(10 marks)**

2) Introduction. A general describing of the topic area and its relevance to networks and communications **(10 marks)**

3) A detailed discussion of the area of relevance in the topic. **(30 marks)**

4) Use of examples, cases, drawings, charts and/or diagrams where and when relevant to help clarify ideas. **(20 marks)**

5) A brief summary of the report **(10 marks)**

6) List of references. References to sources of materials must be clearly indicated i.e. papers, books, technical reports, journals and Internet websites. At least five references are required **(10 marks)**

7) The lecturer's overall evaluation of the report based on clarity and substance. **(10 marks)**

List of suggested topics or areas

01) Parity bit error detection	02) CRC error detection
03) Spanning Tree Protocol	04) Banyan or Delta switches
05) Virtual circuits	06) Traffic balancing
07) Wireless Networks	08) Carrier sense multiple access/CD
09) Any of the Internet Protocols	10) Network Security
11) Datagram switching.	12) Firewalls
13) Virtual Private Networks VPN	14) Star topology
15) TCP	16) IP Addressing
17) Routers	18) Mobile Phone networks
19) Tree topology	20) Token passing media access protocol
21) Shortest Route algorithm	22) Local Area networks.
23) Security protocols	24) Wireless Protocols

Please note that a signed assignment submission sheet is required.

GRIFFITH COLLEGE DUBLIN

QUALITY AND QUALIFICATIONS IRELAND

EXAMINATION

NETWORKS AND DATA COMMUNICATIONS

Lecturer(s):

External Examiner(s):

Date: XXXXXXXX **Time:** XXXXXXX

THIS PAPER CONSISTS OF FIVE QUESTIONS
FOUR QUESTIONS TO BE ATTEMPTED
ALL QUESTIONS CARRY EQUAL MARKS

USE OF NON PROGRAMMABLE CALCULATORS IS PERMITTED DURING THIS EXAMINATION

QUESTION 1

(a) When choosing the fiber optics or satellites as a communication media. Explain your choice when you consider the influence of each of the following requirements in making your decision: security, quantity of data, distances, delays, setup times, noise.

(9 marks)

(b) Explain the operation of synchronous transmission and outline its advantages and disadvantages.

(8 marks)

(c) What is ping utility used for? And what information you would expect the utility to return after execution?

(8 marks)

Total (25 marks)

QUESTION 2

(a) What are the differences between parallel and serial transmission?

(5 marks)

(b) A channel uses the bandwidth between 2MHz and 6Mhz. The signal to noise ratio is 30dB. What is the maximum theoretical data rate of the channel?

(8 marks)

(c) The power of a received signal is measured at 10mW (milliwatts). If SNR is 25dB then what is the power of the noise?

(7 marks)

(d) A radar uses ultrasound for object detection. An ultrasound signal is transmitted by the radar and an echo is received 0.4 seconds later. How far away is the object from the radar? (Speed of sound = 330 ms-1)

(5 marks)

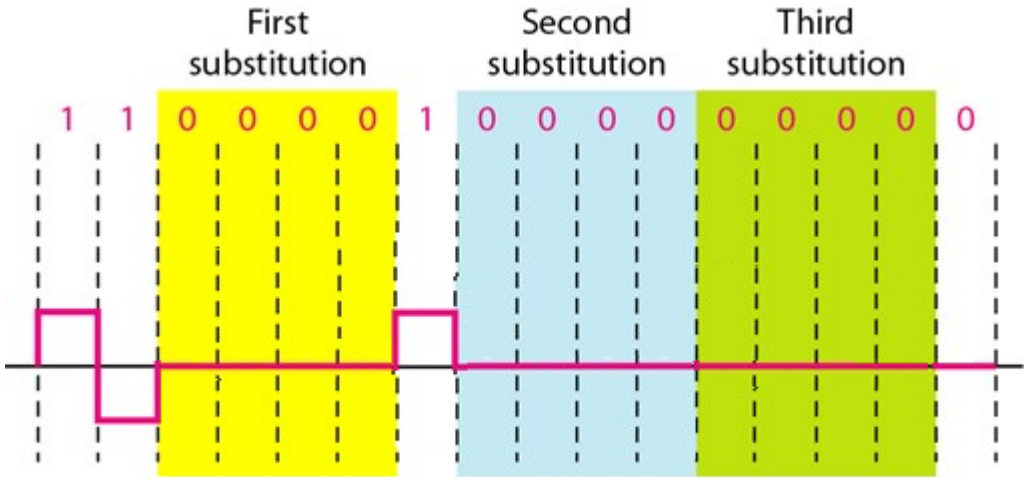
Total (25 marks)

QUESTION 3

(a) Draw the Manchester line code and differential Manchester line code for the bit sequence: 1100110

(7 marks)

(b) The following diagram shows a signal representing the data string: 1100001000000000. Use the B8ZS scrambling technique and redraw the diagrams with the signal pattern generated for transmission.



(6 marks)

(c) Explain the zeros simplification and compression in IPv6 addresses and simplify the following IPv6 address: 21DA:00D3:0000:0000:02AA:00FF:0000:9C5A

(6 marks)

(d) An Ethernet LAN has an Ethernet bridge connecting two or more segments of a network. Explain how the bridge automatically recognizes which packets are to be forwarded and which are to be discarded.

(6 marks)

Total (25 marks)

QUESTION 4

(a) Explain the datagram switching technique.

(10 marks)

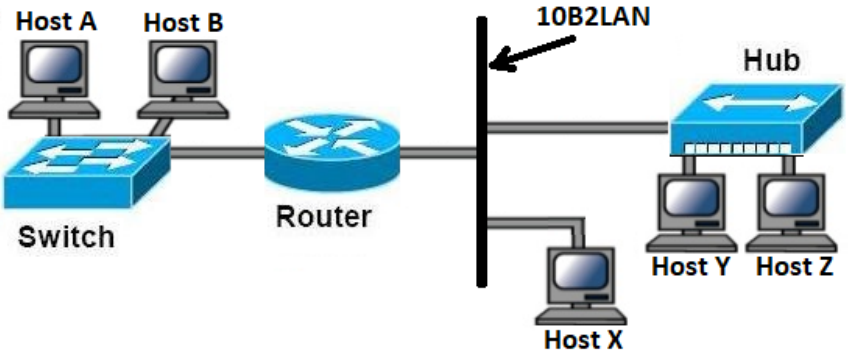
(b) Differentiate between IPv4 and IPv6 addressing in the formatting, size and notation.

(5 marks)

(c) Outline five advantages of digital transmission compared with analog transmission.

(5 marks)

(d) Consider the following network shown in this figure and answer the following questions and explain your answer in each:



1. If Host X send an IP broadcast packet, which end system hosts will receive it?
2. If Host Y sends a packet to Host A, whose MAC address will be inserted in the frame.
3. If Host B receives a packet from Host Z. Whose MAC address will be shown in the frame it receives?
4. While Host Y is transmitting a frame, which other end system hosts will cause a collision if they transmit their frame at the same time?
5. If Host A sends a packet with IP address: 127.5.6.3 then which end system hosts will received this packet?

(5 marks)

Total (25 marks)

QUESTION 5

(a) Explain the digitization process of an analog signal.

(8 marks)

(b) Explain how the following features are made available in an encoding scheme for a signal:

(i) error detection capability

(ii) continuous synchronisation between transmitter and receiver without using a clock signal

(iii) noise immunity

(9 marks)

(c) What is the difference between a repeater and a bridge with respect to each of the following?

(i) The main functions of each.

(2 marks)

(ii) What it connects to on either side of the device?

(2 marks)

(iii) The intelligence of each.

(2 marks)

(vi) The level or layer (of the OSI reference model) at which each operates.

(2 marks)

Total (25 marks)