UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	INDUSTRIAL COMMUNICATION SYSTEMS
COURSE CODE	:	BND 40803
PROGRAMME	:	3 BND
EXAMINATION DATE	:	JUNE/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Four levels of addresses are used in an internet employing the TCP/IP Protocols. Relates these addresses to a specific layer in the TCP/IP architecture

(4 marks)

(b) The OSI model is a layered framework for the design of network systems that allows communication between all types of computer systems. Match the following function to one of the layer of the OSI model.

(i) Route determination
(ii) Transmission of bits across the medium
(iii) Providing user services
(iv) Communication with user's application program
(v) Reliable process-to-process delivery
(vi) Log-in and log-out procedures
(vii) Format and code conversion services

(7 marks)

(c) Propagation time measures the time required for a bit to travel from the source to the destination. However, in industrial data communications we don't just send 1 bit. The time required for transmission of a message depends on the size of the message and the bandwidth of the channel. What are the propagation time and the transmission time for a 3 kbyte data from a temperature transmitter to the Human Machine Interface (HMI) station, if the bandwidth of the industrial network is 1 Gbps? Assume that the distance between the transmitter and HMI station is 500 m and the light travels in the data cable at $2.4 \times 10^8 \ m/s$.

(9 marks)

Q2 **(a)**

(i) Each station on an Ethernet network (such as a PC, workstation, or printer) has its own network interface card (NIC). The NIC fits inside the station and provides the station with a 6-byte physical address. A **unicast** destination address defines only one recipient; the relationship between the sender and the receiver is one-to-one. A **multicast** destination address defines a group of addresses; the relationship between the sender and the receivers is one-to-many. The **broadcast** address is a special case of the multicast address; the recipients are all the stations on the LAN.
Define the **type** of the following **destination addresses**:

a) 8B:70:11:27:10:FF
b) 4E:50:FF:FF:FF:00
c) 1F:FF:EE:DD:BB:AA

(3 marks)

(ii) Fast Ethernet is backward-compatible with Standard Ethernet, but it can transmit data 10 times faster at a rate of 100 Mbps. A new feature added to Fast Ethernet is called **autonegotiation**. Briefly explain this new feature.

(2 marks)

(b)

(i) Change the **208.34.54.12** address from dotted-decimal notation to binary notation.

(ii) Change the **11011111 10110000 00011111 01011101** IP addresses from binary notation to dotted-decimal notation.

(iii) Find the **class** of the 238.34.2.1 IP addresses.

(iv) Find the **netid** and the **hostid** of the 208.34.54.12 IP addresses.

(7 marks)

(c) An organization is granted the block 190.100.0.0/16. The administrator wants to create 500 fixed-length subnets.

(i) Find the subnet mask address   (2 marks)

(ii) Find the number of addresses in each subnet.   (1 marks)

(iii) Find the first and last address in subnet 1.   (2 marks)

(iv) Find the first and last addresses in subnet 500   (3 marks)

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Q3   (a)   Modbus protocol is the most fundamental fieldbus protocol which provide simple way for communicating control data between controllers and sensors using RS232 port. Briefly explain the features of Modbus protocol with respect to the industrial automation applications.

<div align="right">(4 marks)</div>

     (b)

         (i)   The highway addressable remote transducer (HART) protocol is a microprocessor-based process transmitter or actuator that supports two-way communications with a host, digitizes the transducer signals, and digitally corrects its process variable (PV) values. The HART digital signal is modulated on to the 4–20 mA signal at a higher frequency and then observed by process control equipment. In this respect, data transmission time of a HART telegram is important for the performance of process operation. As an instrumentation technologist, in order to identified the performance of HART transmission, you are required to compute the **user data rate [%]** and also **time to transmit one user data byte** with respect to the specific instrument, with the following information:

                 a)   byte per telegram: 20 message characters + 10 control characters
                 b)   bit data rate: 1200 bits/s or 1200 Hz

<div align="right">(4 marks)</div>

         (ii)   Assume that a smart pressure transmitter, for a Yokogawa control system, is to be installed using a shielded twisted pair. Calculate the **maximum cable length [m]** permitted for reliable operation with the following information from the pressure transmitter:

                 a)   Total resistance, inclusive of barriers $R = 300\Omega$
                 b)   cable capacitance $C = 180 \, pF/m$
                 c)   max. shunt capacitance of Yokogawa $C_f = 5000 \, pF$

<div align="right">(4 marks)</div>

(c)

(i)   Foundation fieldbus segment H1 is a single twisted pair wire carrying both a digital signal and DC power that connects fieldbus devices such as temperature, flow, level and pressure transmitters, smart valves, actuators to a control system. As an instrument personal , you are required to examine **maximum number of devices** that can be supported on the particular H1 fieldbus link according to the information provided below:

a) The power supply output is 24 volts
b) The two wires are 1 km long with 30 ohms per wire
c) Each device draws 30 mA
d) Minimum voltage at each device 9 volts
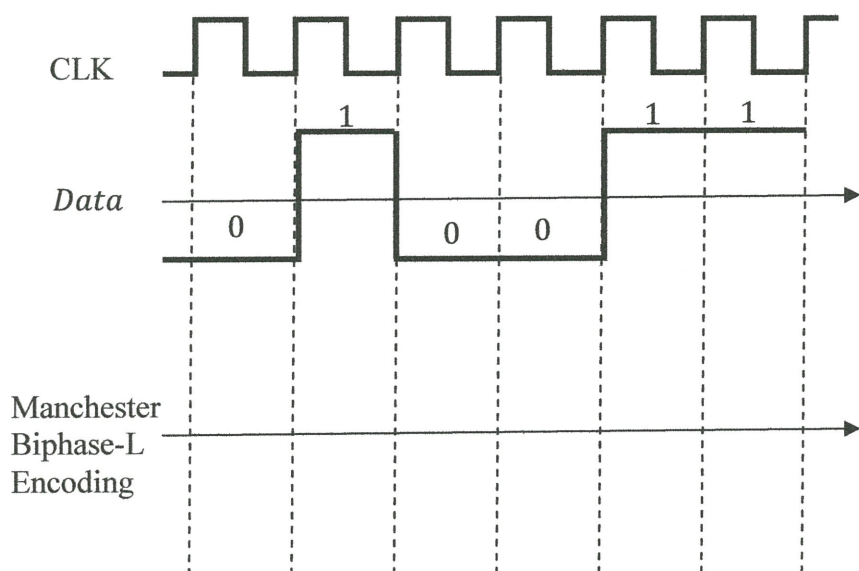
(4 marks)

(ii)   Synchronous serial communication in half-duplex mode is used in H1-Foundation Fieldbus. The Manchester Biphase-L coding scheme is used to code data generated from the field devices and transmitted along the bus. In this coding scheme, there is always a change in the coded pattern at the midpoint of each clocking, irrespective of data pattern. Identify the shape of the Manchester Biphase-L–coded data for an input data pattern 110011 as in figure **Q3 (c)**.

(4 marks)

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FIGURES Q3(c)

Q4 (a)   Explain the main difference between WirelessHART and ISA100.11a from the perspective of flexibility, protocol support, coexistence, security and Quality of service.

(5 marks)

(b)   In the industrial plant, you are given a temperature transmitter which produces a 15 mW of power, express the transmit power in units of

(i)   dBW
(ii)   dBm

(3 marks)

(ii)   If this transmit power 15 mW is applied to a 20 dB gain of antenna with a 2.4 GHz carrier frequency, find the received power P_r in dBm at a free space distance of 1900 m from the temperature transmitter. Assume unity gain for the receiver antenna and additional hardware losses of 1 dB.

(5 marks)

(iii)   In order to achieve the Carrier-to-noise (C/N) ratio of at least 40 dB for the field communication system, The location of the temperature transmitter may need to be relocated. Determine the required **separation distance** in meter (m) between the transmitter and the receiver where the equivalent noise temperature of the receiver T is 290 kelvin and the bandwidth B is 200 MHz.

(5 marks)

What is the impact on field communication system, if the separation distance between transmitter and receiver is 200 m? Explain your answer.

(2 marks)

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Q5 (a) Explain the below security aspects from the perspective of industrial communication systems.

(i) Virtual private network (VPN)
(ii) Firewalls
(iii) Cryptography

(6 marks)

(b) The simplest monoalphabetic cipher is probably the shift cipher. We assume that the plaintext and ciphertext consist of uppercase letters (A to Z) only. In this cipher, the encryption algorithm is "shift key characters down," with key equal to some number. **Encrypt** the message "**THIS IS AN EXERCISE**" using a **shift cipher** with a key of 20. Ignore the space between words. **Decrypt** the message to get the original plaintext.

(7 marks)

(c) In a transposition cipher, there is no substitution of characters; instead, their locations change. A character in the first position of the plaintext may appear in the tenth position of the ciphertext. A character in the eighth position may appear in the first position. In other words, a transposition cipher reorders the symbols in a block of symbols. Encrypt "**INTERNET**" using a **transposition cipher** with the following key:

3 5 2 1 4
1 2 3 4 5

(3 marks)

(d) An asymmetric-key (or public-key) cipher uses two keys: one private and one public. The most common public key algorithm is RSA, named for its inventors Rivest, Shamir, and Adleman (RSA). It uses two numbers, e and d, as the public and private keys, Using $e = 13$, $d = 37$, and $n = 77$ in the RSA algorithm, encrypt the message "FINE" using the values of 00 to 25 for letters A to Z. For simplicity, do the **encryption** and **decryption** character by character.

(4 marks)

- **END OF QUESTION -**