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Department	Industrial Electronics and Control Engineering		No.of Pages	4
			No. of Questions	3
Academic Term	2nd Term, 4th Year		Full Mark	70
Course Name	Industrial Control Syst.		Exam.	Final Exam.
Academic Year	2018/ 2019		Examiner	Dr. Ramy Farid

Answer all the following Questions

Question 1

Draw a schematic diagram for typical SCADA system for the system with the following specifications.

1.1   The field sit contains

A. 3 Magnetic Flow-meters.	H. 10 programmable pressure switches.
B. 5 Flow switches	I. One temperature transmitter.
C. 20 Flow gauges (indicator)	J. 10 temperature gauges.
D. 5 Ultrasonic level transmitters.	K. 2 push-buttons for start/ stop
E. 2 Inductive Level switches, each one has 4 electrodes with different lengths	L. 10 AC three phase motors rotate in two directions (forward / Reverse)
F. 2 pressure transmitters.	M. 5 DC motors rotate forward only.
G. 16 pressure gauges	N. 20 butterfly valves operated manually.

1.2   It's recommended to use M304 PLC as RTU.

1.3   Each RTU is constructed from:

    A.   Rack M340 - 8 slots – BMX XBP 0800

    B.   Power supply module M340 - 100….240 V AC - 20 W – BMX CPS 2000

    C.   Processor module M340 - max 1024 discrete + 256 analog I/O – BMX P34 2020

    D.   Discrete input module M340 - 24 V DC positive – BMX DDI 1602

    E.   Discrete output module M340 - solid state - 24 V DC positive- BMX DDO 1602

    F.   Analog input module M340 - high speed – BMX AMI 0410.

    G.   Flash memory card 8 Mb - BMX RMS 008MP.

1.4   25% spares for all inputs & outputs must be considered in each RTU.

1.5   Now you must determine the number of RTUs with full capacity required to cover all system requirements.

1.6   First three RTUs are connected together as the LAN topology is designed with each node connected directly to a central network hub, or switch before continuing to its destination, the hub, or switch manages and controls all functions of the network.

1.7   Second three RTUs are connected together as the LAN topology consists of main run of cable with terminator at each end, all nodes are connected to this cable.

1.8 Next _three_ RTUs are connected as the first three RTUs, and so on …………

1.9 It's recommended to use _satellite_ communication system for data exchanges between all RTUs and MTU.

1.10 You must determine all required devices for satellite communication system.

1.11 Do you think this system needs sub-master stations and Why?

1.12 Master station is provided with 4 computers, first two of them are connected to MTU as first three RTUs connected to each other and the rest of them are connected to MTU as second three RTUs connected to each other.

1.13 Mention different functions of all computers that are connected to Master station.

1.14 Do you think that we will need a four copy of SCADA software with different license for the four computers that are connected to the master station or one copy for all?

1.15 Mention the functions that can be performed in the commercial data processing level of SCADA system. Illustrate it in the above schematic diagram of the SCADA system.

Now you should be ready to answer all the following

1.16 There are two methods of connecting signal sources to the data acquisition board, compare between them. And which method of them you are used in the above SCADA system?

1.17 Which type of A/D converter is preferred to the analog input modules used above? Why? And then draw a schematic circuit diagram for the analog input modules used above.

1.18 What is means by the input impedance for the analog input module is 54KΩ for 0 …10V, and if the analog input signal is from 4….20mA, what is the input impedance for the same card?

1.19 Above RTUs are considered to be (Small - Medium - Large) RTUs.

1.20 Telemetry refers to …………and it is considered (real time – non real time) system. Why?

1.21 Many operators judge a SCADA system with …………………………………………

1.22 Illustrate that some RTUs and submaster units act as relay back station.

1.23 There are various redundant configurations for master station. Discuss two approaches of them.

Write Comments as You Can.

The <u>Factory Integrated Automation System</u> can be represented as <u>Four Layers</u>.

2.1   Draw a diagram to indicate the components and/or the functions concerned to each layer.

The <u>Manufacture Execution System (MES)</u> is a collection of computer programs, when executed; give the necessary bidirectional information between the <u>Enterprise Resource Planning (ERP)</u> layer, at a side, and the <u>Control and Monitoring</u> layers, at the other side.

2.2   Draw a diagram to indicate the components and/or the functions concerned to <u>each part</u>.

The <u>Process Management</u> is focused on <u>Dock-to-Dock</u> solutions for real-time applications in about12 (<u>twelve</u>) plant systems areas.

2.3   Choose <u>five</u> of the above areas; find the <u>MES</u> solutions for <u>Pharmaceuticals</u> factory.

A Modbus TCP frame, as shown in Fig. 1, is composed of two main components, A Modbus Application Protocol (MBAP) header followed by a Protocol Data Unit (PDU).

3.1   Explain briefly the main purpose of <u>each element</u> in <u>both</u> MBAP and PDU

3.2   Give an illustrative example for both the Modbus Master request and the corresponding Modbus slave reply. Your example shall respect the following:

- The Master requests the Slave device with an IP address <u>192.168.1.15</u>
- The Master is to read the Digital Inputs (DI) starting from the memory address <u>0x0080</u> and the number of registers to read are <u>5</u>
- The function code to read DI registers is <u>0x02</u>
- The binary values of DI registers in the Slave the time of preparing a reply are <u>10110</u>
- Your example shall include a table for both the Master request and Slave rely with all values in <u>Hexadecimal</u>. Each table cell is filled by <u>one byte only</u>.
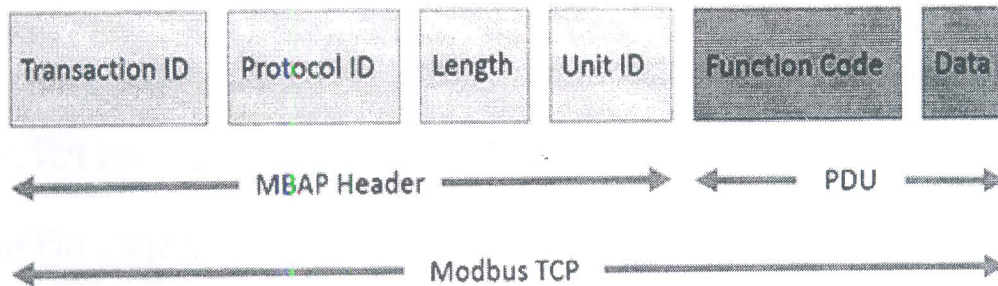
| Transaction ID | Protocol ID | Length | Unit ID | Function Code | Data |

MBAP Header ←————————→ ←— PDU —→

←———————————— Modbus TCP ————————————→

Fig. 1 Modbus TCP Transmission Frame

<u>My best wishes for success</u>

Dr. Ramy Farid