

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY
End Term Examination, 2019

Roll No.....

OPEN BOOK

Course Code : ECE 480 Industrial IoT

Time: 3 hours

Max. Marks: 30

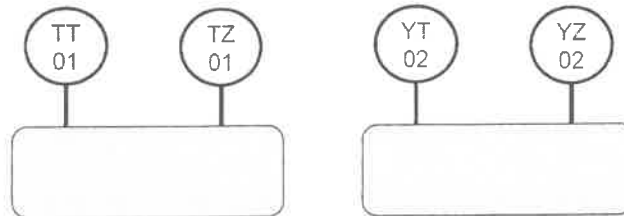
Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1 Toys-for-Kids is a small company that manufactures toys, selling 1000 units/year in average, for children between the age of 5 and 12. Imagine that you are an IIoT Developer and a representative of this company invites you for a meeting because they want to know how "IIoT may be of benefit to them". **Sketch a technical proposal for this potential client.** 05

Q.2 Consider the following P&ID. Assume the four instruments will communicate as slaves with a PLC (master) via MODBUS RTU, with a sampling time of 1s, 24h/365 days of operation. Registers will be coded as 2-bytes-unsigned integers. Note that in this particular case each instrument can be associated to only one MODBUS RTU function and only one slave address.

- Complete the table with appropriate entries (wherever possible)
- How many k-bytes per year should you allocate to this sub-system in your IIoT cloud?
- Imagine one of the slaves wants to transmit 0001 1001b with generator polynomial 0101b. Determine the corresponding CRC.

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Tagname	Description	MODBUS RTU Function Code	MODBUS RTU Slave Address	MODBUS RTU Register Address
TT01	Temperature Transmitter - Loop 01			

Note: ISA S5.1 identification letters and MODBUS function codes are given in next tables

	FIRST-LETTER (4)		SUCCEEDING-LETTERS (3)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	Analysis (5, 19)		Alarm		
B	Burner, Combustion		User's Choice (1)	User's Choice (1)	User's Choice (1)
C	User's Choice (1)			Control (13)	
D	User's Choice (1)	Differential (4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction) (4)			
G	User's Choice (1)		Glass, Viewing Device (9)		
H	Hand				High (7, 15, 16)
I	Current (Electrical)		Indicate (10)		
J	Power	Scan (7)			
K	Time, Time Schedule	Time Rate of Change (4, 21)		Control Station (22)	
L	Level		Light (11)		Low (7, 15, 16)
M	User's Choice (1)	Momentary (4)			Middle, Intermediate (7, 15)
N	User's Choice (1)		User's Choice (1)	User's Choice (1)	User's Choice (1)
O	User's Choice (1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize (4)			
R	Radiation		Record (17)		
S	Speed, Frequency	Safety (8)		Switch (13)	
T	Temperature			Transmit (18)	
U	Multivariable (6)		Multifunction (12)	Multifunction (12)	Multifunction (12)
V	Vibration, Mechanical Analysis (19)			Valve, Damper, Louver (13)	
W	Weight, Force		Well		
X	Unclassified (2)	X Axis	Unclassified (2)	Unclassified (2)	Unclassified (2)
Y	Event, State or Presence (20)	Y Axis		Relay, Compute, Convert (13, 14, 18)	
Z	Position, Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

Table 9.9 Typical Function Codes in Modbus

Function Code	Action	Table Name
01 (01 hex)	Read	Discrete output coils
05 (05 hex)	Write single	Discrete output coil
15 (0F hex)	Write multiple	Discrete output coils
02 (02 hex)	Read	Discrete input contacts
04 (04 hex)	Read	Analog input registers
03 (03 hex)	Read	Analog output holding registers
06 (06 hex)	Write single	Analog output holding register
16 (10 hex)	Write multiple	Analog output holding registers

Q.3 Read the following text carefully:

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"Modbus TCP encapsulates Modbus RTU request and response data in a TCP packet transmitted over standard Ethernet networks. The TCP version includes the application and presentation layers of the OSI model. The slave address is still included and its interpretation varies by application – it is not the primary means of addressing in TCP. The address of most importance here is the IP address. The standard port for Modbus TCP is 502. The checksum field is omitted from the TCP packet. Checksum and error handling are handled by Ethernet. The definition of master and slave is less obvious. Client and server are well known entities in Ethernet based networking. In MODBUS TCP context, the slave becomes the server and the master becomes the client. However, there can be more than one client obtaining data from a server. In Modbus terms, this means there can be multiple masters as well as multiple slaves."

- Using bullet points, explain the differences between MODBUS RTU and MODBUS TCP.
- Describe briefly two different IIoT applications: one using MODBUS RTU + other protocols (excluding MODBUS TCP) and another using MODBUS TCP + other protocols.

Q.4 Consider the following sensor information, extracted from www.digikey.in:

04

ADT7320/ADT7420 16-Bit Digital I2C Temperature Sensor. For high accuracy applications found in industrial, monitoring, and medical equipment applications

ADT7320 and ADT7420 are high accuracy digital temperature sensors. They contain a temperature sensor and a 16-bit ADC. The ADC resolution, by default, is set to 13-bits (0.0625°C) but can be changed through the serial interface. The ADT7320 and ADT7420 are guaranteed to operate over supply voltages from 2.7 V to 5.5 V. Operating at 3.3 V, the average supply current is typically 210 µA. These devices have a shutdown mode that powers down the device and offers a shutdown current of typically 2.0 µA at 3.3 V. These sensors are rated for operation over the -40°C to +150°C temperature range. The CT pin is an open-drain output that becomes active when the temperature exceeds a programmable critical temperature limit.

Identify the features which are more relevant for IIoT applications and explain why.

Q.5 Consider the following periodical discrete time series. Remember that DTFS coefficients are given by

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$$D_n = \frac{1}{K_0} \sum_{k=\{K_0\}} x[k] e^{-jn t_{h_0} k}$$

- Plot the magnitude and phase of DTFS coefficients, as a function of n.
- Determine the average energy of this time series.
- Why this information could be relevant in the context of IIoT applications?

