International Institute of Information Technology - Hyderabad

Communication and Controls for IoT

Final Exam

01 May 2024

- Number of questions: 6; Total points: 50; Time Limit: 90 minutes.
- Use of calculator is NOT permitted.
- This is a closed book exam.
- Write all answers in the answer sheet only. Do not write or mark anything on the question paper. Otherwise you will be penalized.
- Read the questions and marking scheme for each question properly.

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1. **Multiple Choice Question;** Negative marking: 1 point per correct answer; -0.5 per wrong answer; 0 for not attempting! (Total: **12 points**)

   i. A linear strain sensor has sensitivity of 100 V/% and zero offset of +1 V. What is the output for a strain of 450 ppm?

   (A) 451 V (B) 4.5 V (C) 0.45 V (D) 5.5 V

   ii. Which of these interrupts has the lowest priority in ATMEGA328:

   (A) INT0 (B) INT1 (C) Analog_vect (D) ADC_vect

   iii. Which prescalar will generate the slowest timer?

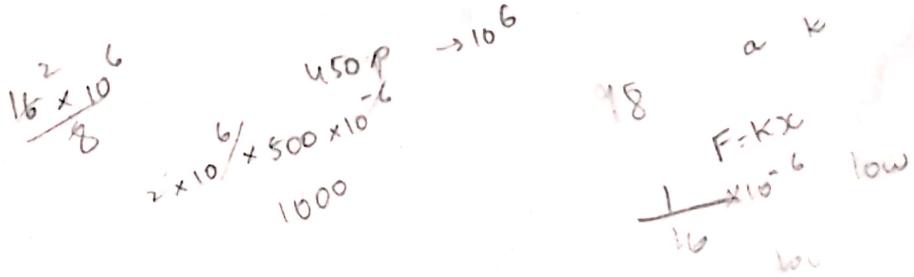
   (A) No prescalar (B) 8 (C) 64 (D) 1024

   iv. What is the value of OCR1 if we need to count 500 μs using a 16 MHz clock with a prescalar of 8?

   (A) 0x3E7 (B) 0x999 (C) 0x1000 (D) 0x9F

   v. A comb-drive structure with a known spring constant can be used to measure:

   (A) Acceleration (B) Force (C) Mass (D) All of above



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vi. CSMA cannot avoid collisions because of

(A) Congestion in the routers
(B) Hidden node problem
(C) Nodes try to send data without sensing
(D) Receiver is sleeping

vii. Which one of the following is the best physical layer technology for all IoT applications?

(A) LoRaWAN
(B) WiFi
(C) Cellular
(D) Depends on the application

viii. Which one of the following protocol has the best security?

(A) IEEE 802.15.4
(B) LoRaWAN
(C) WiFi
(D) 5G

ix. Polling protocol is used in

(A) Zigbee
(B) Bluetooth
(C) LoRaWAN
(D) Cat-M1

x. UDP is a commonly used protocol at

(A) Application layer
(B) MAC layer
(C) Network layer
(D) None of the above

xi. Over hearing is a major issue in

(A) Channel partitioning protocols
(B) Random assignment protocols
(C) Demand assignment protocols
(D) Both (B) and (C)

xii. In MQTT, if QoS of the published message is 1, then the quality of service possible for the received message at the subscriber is

(A) 0
(B) 1
(C) 0 and 1
(D) 0, 1 and 2

2. **True or False (With Reasoning)**: 1 mark per bit only if both the statement (T/F) and reasoning are right; 0 otherwise (Total: **8 points**)

i. An n-bit Kelvin divider DAC requires $2n$ resistors.

ii. Zero offset is a desirable property in a sensor.

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iii. Millis() in Arduino uno can be used to time between events occurring 30 days apart.

iv. Simple sensors such as water level (in the overhead tank of a home) reveal sensitive private data.

v. Interoperability is an important issue in IoT.

vi. Mic-speaker is an example of *duplex* communication systems.

vii. In message queing telemetry transport (MQTT), message queues are used at brokers.

viii. Only one publisher to one or many subscribers is possible in MQTT's publish-subscriber model.

3. In a 4-bit R-$2R$ ladder DAC, the reference voltage range is from 4.8 V and the output should be from 0 to V_{ref}. The total current drawn needs to be limited to 100 mA, what is the minimum value of R. For this R, what is R_f? **(10 points)**

4. Explain the five layers of the TCP/IP Internet Protocol Stack using only few sentences per layer. **(5 points)**

5. Write comparison of HTTP and MQTT with respect to the following points: data type, pattern, complexity, message size, data distribution, QoS, libraries, power consumption, scalability. For each point of comparison, write answer in few lines. **(5 points)**

6. Forest fires have resulted in a loss of life and wealth in countries like the USA and Australia over the last decade. Develop an IoT-based system which will help in preventing or managing forest fires. Also include features which can minimize loss of life and wealth in such scenarios. You have to write your answer to this question by strictly following the steps given below. Clearly write the step number before answering the particular step. **(Total: 10 points)**

   (a) **Selection of components**: Explain which microcontroller, sensors, actuators, type of ADC/DAC (if required) and any other hardware will be required to develop the desired system. Clearly explain the rationale/reason behind selecting every component. Also mention with reason, the physics of the sensor you select. (2 points)

   (b) **Block diagram of the circuit**: Draw a neat block diagram of the proposed circuit. Mention the type of interfaces (UART/SPI/I2C/etc.) and any other information deemed important. (2 points)

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(c) **Communication Technology**: Clearly explain with reasoning, the choice of PHY layer protocol, topology and any other scheme of communication. What are your selected design parameters such as low power, range, latency, data rate, etc? (2 points)

(d) **Application layer protocol**: Which application layer protocol would you like to use and why? What QoS is required for the application and why? (2 points)

(e) **Flow Chart**: Draw a neat flow chart of the complete system operation. You might want to include any other system detail not coverd in the above steps in this flow chart. (2 points)

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