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**Instructions:** Read the questions carefully. **Answer to the point. Answer all parts of a question at the same place.**

**Q1.** Answer the following questions about sensors [10M]

- You have an application for temperature reading where you need the measuring range to be very large, but the cost to be very low. What kind of temperature sensor would you use? Explain in brief the working phenomenon of the same. Also mention some challenges/ limitations of that particular kind of sensor? [3M]
- You have devised a new pH sensor. How do you test its performance (in real life)? You take a 6 pH solution and take 5 readings using sensor. The readings which you get (using your sensor) in various iterations are 5.5, 5.7, 5.9, 6.3, 6.7. Comment on the precision and accuracy of the sensor. [3M]
- What does selectivity of a sensor mean? Give an example to explain the same? [2M]
- Typically, a sensor is expected to give a current/voltage output which is calibrated by an external microcontroller to evaluate the parameter it measures. However, the DHT11 sensor gives the values of the parameters it measures in digital format, how is that. Explain? [2M]

**Q2.** Answer the following questions about actuators [14M]

- What is the purpose of gearbox in the servo motor? [1M]
- You have a rotary actuator requirement where you want the rotor actuator to freely move at a high speed. Which rotary actuator will you use for this purpose. [1M]
- What are key differences between servo motor and a stepper motor. [2M]
- There is a 8 pole stepper motor. What is the maximum number of steps which it can take. How can that be achieved? [2M]
- You are using a humanoid which has a servo motor in the key arm component (the rating of the motor is 5 kg-cm). Assuming the hand to be of 10 cm span (/size), how much load can the humanoid safely lift. [2M]
- Draw the schematic of a Triple pole single throw (TPST) Normally closed (NC) relay. [2M]
- On what basis are actuators classified as isolation, modulating and regulating actuators. Mention the specific details based on which they are thereby classified into these classes. [2M]
- Actuators to be used in dusty environment need to be \_\_\_\_\_ compliant. Actuators to be used in wet environments need to be \_\_\_\_\_ compliant. Please answer in the answer sheet. [2M]

**Q3.** Answer the following questions about sensors/ actuator interface [12M]

- What would you need to do in the nodemcu code snippet to enable the communication between DHT11 sensor and the Nodemcu? [1M]
- What is the most popular Operating system used in raspberry pi [1M]
- What is the specific significance of serial communication when coming to microcontrollers like arduino. Explain using some real life example. [2M]
- When you insert these lines in code, how many seconds of delay is introduced in the following cases?  
a. delay(5) - arduino b. time.sleep(5) - raspberry pi [2M]
- Mohan is starting a startup to cater to the AI (artificial intelligence) analytics needs for companies like amazon, flipkart, ebay etc. He introspects diverse customer application requirements and plans to promise a short delivery time, however ensuring his profit to be maximized. Which of the cloud services would best suit his purpose (IaaS, PaaS or SaaS) and why? [1M + 1.5M = 2.5M]
- What are the three primary characteristics of big data. [1.5M]
- In what aspect does edge computing offer more secure processing as compared to cloud computing [2M]

Q4. Answer the following questions [12M]

a. What is done in blockchain to ensure that block creation/mining frequency is on an average 10 minutes and

does not become very less [1M]

b. What is the typical size constraint on a block in bitcoin and why is that size constraint imposed on the blocks. [2M]

c. A miner picks up 4 transactions from the mempool and checks for various nonce values to hit a hash value below the target hash value. He fails in doing so while just 0.25 seconds have passed. What does he do next in the rest of the 0.75 seconds to increase his chances of mining a block. [2M]

e. Consider the following 5 transactions in the mempool. The miner can take only 3 transactions at a time due to the block size constraint. If the miner mines the block, what is the maximum overall incentive in bitcoins that he can get from the network (overall incentive) for mining the block. [2M]

*Transaction 1, Mohan -> Sohan 10BTC, processing fee: 0.1BTC*

*Transaction 2, Ram -> Shyam 2BTC, processing fee: 0.05BTC*

*Transaction 3, Amir -> Muhammad 5BTC, processing fee: 0.12BTC*

*Transaction 4, Jesus -> Martin 6BTC, processing fee: 0.08BTC*

*Transaction 5, Ram -> Nour 1BTC, processing fee: 0.01BTC*

f. Why could conventional bitcoin based blockchain not be used for IoT applications so easily. Which feature of ethereum overcame those limitations. What were the challenges which had to be solved to use the proposed solution safely for IoT applications. [2M]

g. What is the significance of gas price in running a smart contract. What is gas limit. Who sets the gas limit. What happens if the gas required is more than the gas limit. [3M]

Q5. Answer the following design questions (note that you are expected to show technical implementation using a figure including *sensors, actuators, microcontrollers, processors, connections* etc. except code, highlight specifics of the system by writing it). [12M]

a. In a cold drink manufacturing facility, two liquids (Liquid1 and Liquid2) need to be mixed in a predetermined proportion to make the desired Juice. The working of the facility is as follows. The industrial juicer drum has a predetermined quantity of Liquid1. There is a mechanism (to be designed) using which the operator can make the drum rotating (he should have flexibility to smoothly control the speed of the rotary drum). Liquid2 is then gradually added in the drum (which is rotating), while measuring the pH value of the solution. When the pH reaches 6.8, Liquid2 no more needs to be poured, and the rotating drum also should gradually stops rotating (the drum power supply should be cut as soon as pH of 6.8 is detected). Design such a system cost-optimally (while accounting for all these operations) highlighting key technical details (e.g. sensors, actuators, microcontrollers, connections etc.). [6M]

b. You have to develop a smart meter for monitoring the real time electric power consumption of house. How would you design the system? Please give technical details of design. Do ensure that you design the smart meter system in a way that it can support running various lightweight ML models locally before sending the electricity data to the cloud. [3M]

c. Draw a level 4 IoT system for IoT based water tank level monitoring highlighting key details. [3M]