200

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATIONS- 2026

B.Tech-IV Semester (CSE/IT/BT)

COURSE CODE (CREDITS): 25B1WCI433 (2) MAX MARKS: 35

COURSE NAME: FUNDAMENTALS OF SMART SYSTEMS AND IOT

COURSE INSTRUCTOR: AAYUSH SHARMA MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

(c) Use of calculator is allowed

You and three batchmates have been selected by the college to build **HOSTEL-GUARD**, a smart safety system for Blocks A, B, and C that detects unauthorized entry, gas and smoke hazards, late-night exits, and unsafe room conditions. You have 6 months and a budget of Rs. 50,000. The questions below follow your journey month by month.

<table>
<tr><th>Q. No</th><th>Question</th><th>CO</th><th>Marks</th></tr>
<tr><td>Q1</td><td>Your team finalises the main system blocks before buying any hardware. Match each item in Column A with the correct description in Column B:
<table>
<tr><th>Column A</th><th>Column B</th></tr>
<tr><td>ESP32 in Wi-Fi station mode</td><td>Sends selected sensor readings to a cloud dashboard for the warden to view</td></tr>
<tr><td>ThingSpeak channel</td><td>Connects the node to the hostel Wi-Fi router</td></tr>
<tr><td>MQTT Last Will and Testament message</td><td>Notifies the dashboard automatically if a node disconnects unexpectedly</td></tr>
<tr><td>ESP32 deep sleep</td><td>Reduces power consumption between sensor readings</td></tr>
<tr><td>Local alarm path</td><td>Keeps the safety buzzer and LED working even when the internet fails</td></tr>
</table></td><td>[CO1]
[CO2]
[CO4]</td><td>[5]</td></tr>
<tr><td>Q2</td><td>Month 2:
The team decides to run long physical sensor wires from rooms on every floor to a central unit in the hostel office. The door reed-switch input is pulled up to 5 V in the old Arduino circuit, and this 5 V signal line is wired directly into an ESP32 GPIO input pin because the ESP32 upgrade is planned for later.
(a) Explain why a PIR sensor is well-suited for detecting silent late-night movement near a hostel exit, but is not reliable for confirming the identity or exact number of students present in a room.
(b) The fire warden wants early warning if the pantry or corridor becomes unsafe due to smoke or gas. Suggest one suitable sensor from our toolkit. State where it should be physically placed and explain why that placement is correct.
(c) State two practical challenges of running long sensor wires through a 5-floor hostel block for long-term deployment.</td><td>[CO1]
[CO3]
[CO5]</td><td>[2+2+2]</td></tr>
<tr><td>Q3</td><td>Month 4:
Before installing the wireless system, your team wants to verify that the planned MQTT load, cloud update schedule, and battery life are realistic on paper.
(a) The MQ-2 smoke sensor in the Block B pantry outputs 2.1 V. Your team assumes the ESP32 has a 10-bit ADC with a 3.3 V reference. Calculate the raw ADC reading and the voltage resolution in mV per step.
(b) Each floor node publishes one MQTT packet every 20 s. Payload = 35 bytes,</td><td>[CO4]</td><td>[2+2+2]</td></tr>
</table>

	overhead = 22 bytes. Calculate the total MQTT bytes per second for one floor node. Your team also plans to push data to the same ThingSpeak channel via HTTP GET every 5 seconds per floor. For 3 floors, calculate the total HTTP requests attempted in one hour. Using the ThingSpeak update interval discussed in class, does this plan comply? Answer yes or no and justify in one line. **(c)** Each ESP32 node is active with Wi-Fi for 0.5 s at 240 mA, then in deep sleep for 19.5 s at 10 μA. Battery capacity is 2000 mAh. Calculate the average current drawn per cycle and the estimated battery life in days		
Q4	**Month 5:** The team prepares the final alert logic. To avoid disturbing students unnecessarily at night, they agree on the following rules: from 10 PM to 6 AM all alerts will be silent MQTT notifications only; from 2 AM to 4 AM, an unauthorized door opening will additionally trigger the floor buzzer. **(a)** Write step-wise decision logic or draw a simple flowchart for the hostel node using these five inputs: gas or smoke detected, door open, motion detected, current time, and current alert mode. Your logic must clearly show which condition triggers a silent alert only, which triggers the floor buzzer, and what happens when multiple conditions are true at the same time. After your logic, state the priority order of the three event types and explain in two lines why defining priority matters in a safety system. **(b)** Your team must verify whether the battery can last the academic semester. For a 2000 mAh battery and a 180-day semester requirement, derive the maximum average current allowed. Compare this value with the average current calculated in Q3(c). If the design does not meet the requirement, suggest one hardware or software change to extend battery life.	**[CO5]**	**[3+3]**
Q5	**Month 6:** After one week of full deployment, a minor smoke incident occurs in the Block B pantry at night. No one is injured, but the warden requests a technical review. During the incident, the system showed four problems: (1) the MQ-2 sensor value displayed on the dashboard did not match the expected smoke level; (2) several cloud updates did not reach the warden's phone during the critical period; (3) the local floor buzzer did not sound for the smoke condition because the system treated it as a routine silent-night event; (4) the ESP32 board connected to the Block B main door sensor stopped responding completely the morning after the incident. **(a)** Go back through your earlier phases and identify the design mistake that caused each of the four problems above. For each problem, state the phase or question where the mistake was introduced, explain exactly what the error was, and write what it should have been. **(b)** Following the incident, the administration proposes replacing HOSTEL-GUARD entirely with facial-recognition cameras at every hostel entrance to save the project funding. As the original design team, write your response: two technical limitations of a camera-only approach for hostel safety, two privacy or ethical concerns with deploying facial recognition in a student residence, and two specific reasons why your corrected HOSTEL-GUARD design is better suited for the actual safety requirements. **(c)** The block diagram below shows the original Block B system design submitted by your team at the end of Month 4. Two design choices in this diagram are incorrect and directly contributed to the pantry incident. Identify both errors, explain the consequence each one had during the incident, and state the correct design choice that should replace it.	**[CO4]** **[CO5]**	**[4+4+4]**