

**Birla Institute of Technology & Science, Pilani, Pilani Campus**  
**II Semester 2022-2023**  
**EEEG627 Networked Embedded Applications**  
**Mid-Semester Examination (Closed Book )**

Date:15-3-2023

Duration: 90 Minutes

Max Marks: 25

Q.1. PAMAS routing protocol reduces overhearing, and hidden terminal problem. Do you agree with the statement? Justify. Your answer should reflect the understanding of PAMAS, overhearing and hidden terminal problem. [2M]

Q.2.

a.) The RSSI value reported at node A in dBm when message is received from node B and C is -30 and -35 respectively . Which of the nodes (B or C) is closer to Node A and why? A, B and C are static nodes. The RSSI recorded at Node A on another message reception from B is -31dBm. Mention the equation which can be used to relate RSSI with distance and explain the reasons for the variation in RSSI reported at node A due to message B (mention 3 probable reasons).

b)

Three nodes A, B, and C are known to be positioned at locations (0, 0), (10, 0), and (4, 15), respectively. Node D is estimated to be a distance of 7 from A, a distance of 7 from B, and a distance of 10.15 from C. Determine the location of D using trilateration. [3M]

Q.3.

(a) In a synchronized network with unknown synchronization error which uses Time of Arrival (ToA) as the ranging technique, an anchor node periodically broadcasts an acoustic signal (assume a propagation time of 300 m/s) to sensor nodes in its range. At time 1000 ms on the anchor node's clock, the anchor node issues a beacon, which is received by node A at time 2000 ms (on node A's clock). What is the distance that A can now compute?

(b) Instead of computing the distance itself, node A also responds with an acoustic signal issued at time 2500 ms, which is received by the anchor node at time 3300 ms. What is the distance computed by the anchor node? What can you say about the synchronization of anchor node and node A (Are they perfectly synchronized, which one is fast/slow)? [2M]

Q.4. Compare the pros and cons of 1-persistent and p-persistent MAC. (Writing the definition is not enough.) Pros and cons should be highlighted. [2M]

Q.5.

a. What is the relevance of 2 contention windows in the beacon-enabled mode in 802.15.4?

b. Mention how the battery life extension, SO and BO can be used for maximum energy conservation in the beacon-enabled mode in a 802.15.4 node. [2M+2M]

**Q. 6. Marks will be awarded for the design elements presented. Do not write irrelevant, generic statements in the answer. The implementation of every statement made should be reflected in the design.**

You are expected to design a Smart Street lighting system for BITS Pilani Campus. As a part of the pilot project, you are expected to demonstrate the operation for a street (Gandi Marg) from the BITS front gate to the BITS back gate. The street has posts with streetlight on either side of the road as shown in the diagram. The posts are placed at a distance of 2.5m from each other on either sides. The placement of the posts on left and right sides are staggered such that there is at least one post on right handside between two posts on left hand side as shown in figure.



Each post has a solar panel. Each post supports lighting based on line power and the solar power. If the battery in the post is adequately charged from solar power, the light is turned on due to solar power, else the line power is used to turn on the light. The post is also mounted with proximity sensors (both thermal proximity- which detects the presence of human beings/animals and movement detectors). Each post has also a temperature, and humidity sensor to monitor the weather at a given location, light sensor to monitor ambient light and the benzene sensor to monitor the air quality. The posts act as WSN nodes and the nodes form an ad-hoc network to communicate with other nodes in the network to ensure that minimum number of lights are ON (to ensure adequate lighting) based on the proximity sensors and ambient light. Also the lights will be turned ON based on the ambient intensity of light and the time set (say only between the 6pm to 4am) by the basestation. Assume that each sensor provides 1 byte of data output. The data from the post can hence be used to obtain the weather profile as well as the movement pattern of the residents in the campus while optimizing the use cost involved in street lighting.

**Reducing the overall cost of deployment (initial and recurring) while ensuring adequate lighting is the main design goal. Each node has a communication range of only 10m.**

The data from each WSN node has to be transmitted to the WSN sub base station which is kept at one end of the street. The WSN sub base station collects the sensor data from the WSN nodes and sends it to the basestation for further monitoring and action. The response based on the proximity sensors are event driven. Other sensors are recorded at an interval of 5 minutes and the same is to be transmitted to sub-basestation so that real-time viewing of condition on streets can be monitored from the subbasestation or base station. Design the WSN for the system mentioned above (for only one street. Subbasestation to basestation communication need not be designed). With time, more streets each with its own sub-basestation will be added/removed from the system. You are allowed to add additional structures or nodes if it is essential. If additional structures/nodes are used justify the requirement. **Mention Assumptions if any.**

- a) Describe the network topology, control and data patterns in the network. How do nodes decide to turn on/off the lights . Which nodes make the decision.
- b) Do you think time synchronization is required to be implemented? Mention the reasons. If so mention/describe a synchronization scheme.
- c) Do you think localization is required to be implemented? How will you design the system?
- d) Propose a MAC protocol for the system. ? Justify the scheme.
- e) What will be a suitable routing protocol for this WSN ? Justify the scheme.
- f) Now consider in the above-mentioned WSN, a WSN node (M) on a streetlight is misbehaving due to some reason. The node M was supposed to act as a relaying node and send the packets it is receiving to the WSN node (N). However, instead of sending the packets to node N, the malicious node M is dropping the message selectively/randomly. How will we mitigate this type of attack in the WSN? Be specific. [12M]

