2018-201700273-1B– Cyber Physical Systems
track Wireless Sensor and Actuator Networks, 2018-2019.

This exam contains of 5 questions that each have equal weight. All questions can be answered in less than 10 lines, so be clear and concise. You have up to 90 minutes to complete this exam. No external literature (like books, slides, etc.) is allowed.

Good luck.

1) MAC protocols are an essential element to establish communication in a Wireless Sensor Network.
   a) What are the 3 major reasons why it is difficult to have an efficient MAC protocol in WSN?
   b) What are the two major advantages and 2 major disadvantages of a scheduled based MAC protocol?

2) In WSN ad hoc multi-hop routing protocols are often used to establish a communication between sender and receiver. There also exist single hop networks, such as used in LoRaWAN. There is a difference in energy consumption when communicating a message from a source to a destination, either via one hop or via multiple hops.
   a) How could a multi-hop network be more energy efficient than a single hop network?
   b) Why isn't that always the case? What are the reasons?

3) A common classification in routing protocols is 1) pro-active and 2) on-demand.
   a) What is the difference between a proactive routing protocol and a reactive routing protocol?
   b) Consider the following WSN scenarios and explain why you would choose either a proactive or a reactive routing solution:
      1) A WSN is used to monitor air pollution in a city where every sensor reports its sensor data once every minute to a single remote base station. Most sensors are mounted on lamp posts, but some are also mounted on city buses.
      2) A WSN is used to measure humidity in a field, where low-power sensors report measurements only when certain thresholds are exceeded.
      3) A WSN is used to detect the presence of vehicles, where each sensor locally records the times of vehicle detection. These records are delivered to the base station only when the sensor is explicitly queried.

4) Flooding is a simple strategy for distributing data to one specific node or all sensor nodes in a network. A gossip protocol could solve some of the challenges.
   a) What are the main challenges with a flooding protocol?

b) How can these be addressed in the network protocol?
c) Explain briefly how a gossip protocol works.
d) What challenges does a gossip protocol solves, and what still remains?

5) In industrial wireless networks reliability and low latency are important performance metrics.
   a) What are methods that can be used to improve reliability?
   b) What methods can be used to have a predictive latency?
   c) Mention the names of two protocols that are used in industrial wireless networks.