



Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
E L 0 2 4 A	T 1 0 2	2 0 1 8 - 0 8 - 2 4
Kursnamn	Elektronik AV, Sensornätverk	
Provnamn	Skriftlig tentamen	
Ort	Sundsvall	
Termin	H18	
Ämne	Elektronik	

Exam in Sensor Networks (VT2018)

Course codes: EL024A

Date:	2018-08-24
Duration:	5 hours
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Maximum achievable points:	100
Minimum required points to pass:	50
Aids (Hjälpmedel):	Calculator, Dictionary

General Instructions

- Begin the answer to every question on a separate sheet of paper
 - Do not write in red color
 - For every calculation, the way towards the result has to be clearly understandable
 - Direct citations from lecture slides will not be accepted as an own contribution
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Questions

1. As a wireless sensor system engineer you are responsible for the design and development of new device implementations. Your company just landed a new project, in which a platform for precision agriculture should be developed. You have been assigned the development of the hardware for the individual sensor nodes. For the first project meeting, you are asked to present some initial ideas about the design.
 - (a) Explain what a sensor node is and what modules it contains. (4)
 - (b) Assume that the application requires a network with many nodes, periodically sampling scalar data such as temperature, humidity and soil water content, with small node-to-node distance. Describe your thoughts on the potential implementation of each of the node's modules. Motivate your choices. (6)
 - (c) Explain how the modules on the node will interact with each other. (4)
 - (d) Motivate the importance of the design considerations: *lifetime*, *cost* and *size* for the given application scenario. (4)
2. Application programs on wireless sensor nodes often operate with the help of lightweight operating systems. Program execution in these systems can traditionally be divided into being *multi-threaded* or *event-driven*.
 - (a) Explain the difference between these two approaches. (4)

- (b) Why can multi-threading solutions be regarded as problematic in wireless sensor systems? (4)
 - (c) Contiki utilizes protothreads. Describe how protothreads could be interpreted as a compromise between multi-threading and event-driven implementations? (4)
3. In order to transfer data from a source to a destination, a wireless communication system has to perform a number of tasks/steps on both the sender and the receiver.
- (a) Describe these steps in a digital communication system (from analog signal on the sender, to its availability on the receiver). (8)
 - (b) Assume that a transmitter utilizes a 4-PSK modulation. What does this mean? (4)
4. Wireless communication in wireless sensor networks typically occurs on the ISM band.
- (a) What are the main advantage and disadvantage of utilizing the ISM band, respectively? (4)
 - (b) Explain how interference affects communication in a wireless link between transmitter and receiver. (4)
5. A wireless signal transmitted by a node is said to experience path loss.
- (a) Explain what *path loss* actually refers to. (4)
 - (b) How is path loss affected by the gain (directionality) of the transmitters antenna? (4)
 - (c) Assuming a free-space approximation, a carrier frequency of 2.45 GHz, and an output power of 1 dBm, what is the received power (in dBm) at a distance of 100 m. Circuit losses and antenna gains can be neglected. (4)
6. CSMA is a common protocol implementation in WSNs.
- (a) What layer does CSMA operate on, and what is the main objective of this layer? (4)
 - (b) CSMA performs carrier sensing. Explain what this means. (4)
 - (c) Motivate why carrier sensing may be insufficient in a hidden-terminal situation. (4)
 - (d) What can additionally be done in order to address the hidden-terminal problem? (2)
7. Explain the difference between unicast, multicast and broadcast communication in a network. (6)
8. Routing is a two-step process.
- (a) Describe the two steps a routing protocol needs to perform. (4)
 - (b) What does the term *Routing metric* refer to? Exemplify two routing metrics that could be relevant to wireless sensor networks. (4)

9. Assume a WSN using a TDMA communication scheme. The gateway/sink of the network has a direct link to all nodes in the network and provides each node with a 5 ms communication window (time slot) once an hour. As nodes are only permitted to communicate in their time slot, they can enter a low-power mode otherwise.
- (a) Calculate the duty cycle of a sensor node in this network. (2)
 - (b) What is the energy consumption of a node under this scheme if the current consumptions during active periods is $I_a = 25$ mA and during inactive periods is $I_s = 10$ μ A. A constant voltage supply of 3 V can be assumed. (4)
 - (c) Explain why this scheme would be referred to as a *synchronous duty cycling*. (4)
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Equations

$$P_{RX} = \frac{P_{TX} \cdot G_{TX} \cdot G_{RX} \cdot \lambda^2}{(4\pi)^2 \cdot d^2 \cdot L} \quad (1)$$