laSalle ENG
Universitat Ramon Llull

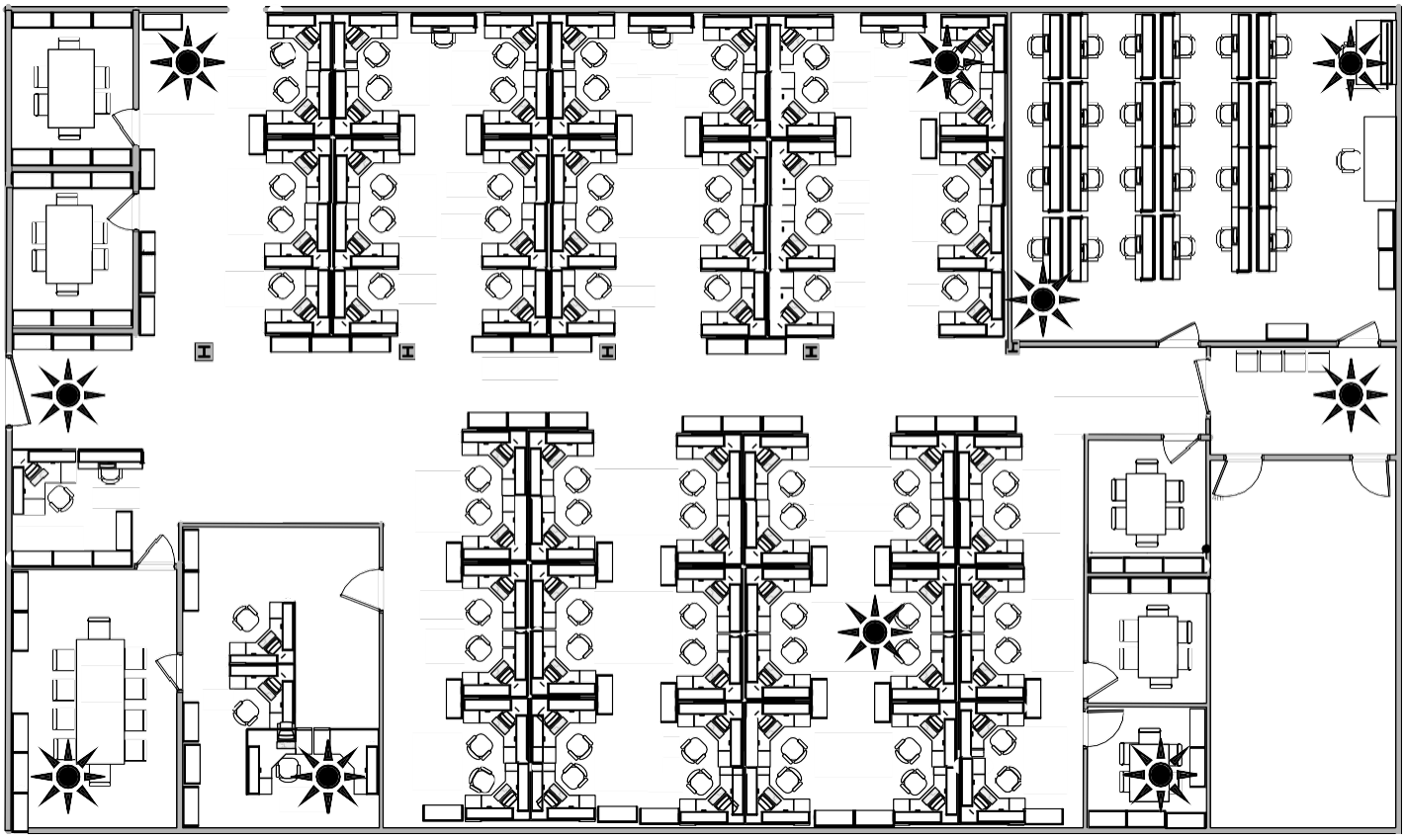
June Exam – Second Semester

Subject: Digital Systems and Microprocessors
Date: 06/06/2017

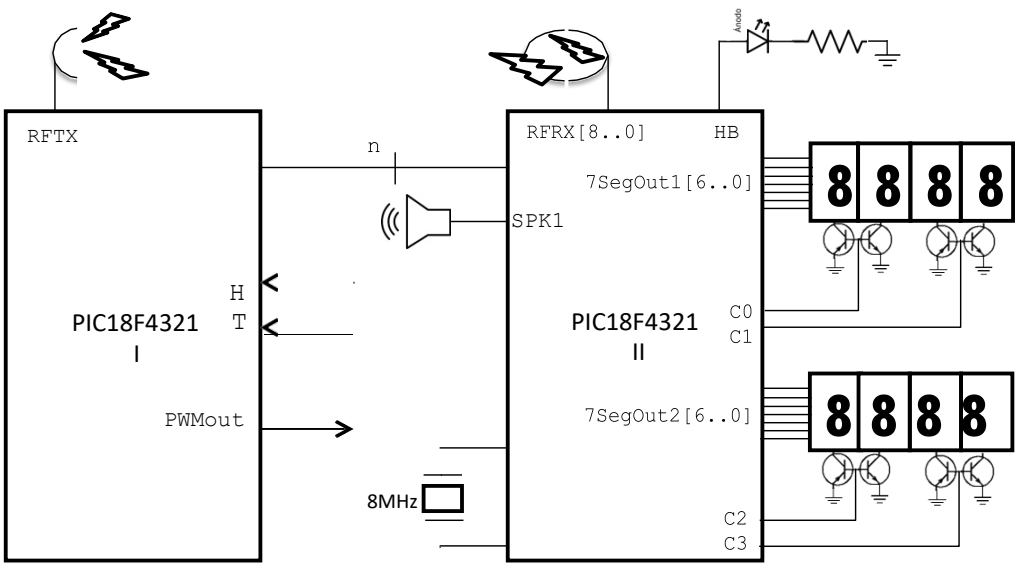
Surname: _____ Name:_____Login: _____ Year: **2016/17**

Internet of ~~Things~~ PICs (IoP)

A system capable of monitoring when there is a flooding or fires at big surfaces must be designed. To do it, 10 devices based on the microcontroller PIC18F4321 will be placed at the most critical locations so all the surface is covered. Each device will acquire the value of the temperature and humidity at its position and will send it to the other 9 devices through a radiofrequency link, like the one you have used in the practical assignment. To avoid collisions (-3) at the radioelectric space, a modem working in a different frequency will be assigned to each device. The following figure shows an example of a possible scenario where the circles represent each of the 10 devices that must be implemented.



Each device must sample the humidity and temperature values of its zone, listen to the values that the other 9 neighbor stations have read, show the humidity and temperature values of each station and activate an alarm in case of a critical situation. Each of the 10 devices will have the following configuration:



The system specifications are explained below:

- Humidity and temperature acquisition (`H, T`): The humidity value (`H`) will range between 3V (inundation) and 4V (dryness). The temperature value (`T`) will range between 0V (cold) and 5V (hot). The two analog inputs must be sampled every 1 second with the maximum resolution possible.
- Pulse generation (`PWMout`): While the system is not processing the humidity and temperature samples, a pulse train must be send with a period of 69 uS and a 50% duty cycle.
- Data transmission (`RFTx`): Once the humidity and temperature values have been acquired, the following message must be send through the `RFTx` output: "I am the station XX. The humidity and temperature values are: YYYY/ZZZZ.CC". Note that the XXXX & YYYY are the ASCII values of humidity and temperature and the two bytes CC are the checksum of the complete string.
- Data reception (`RFRx[8..0]`): The system needs to listen and process the messages sent from the 9 neighboring stations. The messages whose checksum is not correct must be discarded.
- Humidity/temperature visualization: Four 7-segments displays will show cyclically each second the humidity value of each station. At the same time, the other four will show the humidity value.
- Alarm: When all the stations surpass the 70% of the maximum value of humidity and/or temperature, (1) a sound must be emitted through the speaker (`SPK1`) at a frequency proportional to the average value of the parameter that is causing the alarm and (2) the LED (`HB`) needs to display a heartbeat at 50Hz period.
- There is cabled communication between the two microcontrollers. If you need it, you can make that both microcontrollers speak between them.

To do:

a. System approach: pins assignation, radiofrequency communication protocol (bit time, bit codification, etc.), justification of the programming languages of each microcontroller, communication strategies between the two microcontrollers and interrupts used.
b. Sketch of the main of the uC I (it is not necessary to implement any subroutine, but you need to write the pre and post-conditions).
c. Subroutine to sample the humidity and temperature and its conversion to ASCII of the uC I.
d. ADTs diagram and dictionary of the software of the uC II.
e. State machine of 4 significant motors of the uC II.
f. Implement 2 significant ADTs of the uC II.

Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.

Winston Churchill