Lecture diary

This diary will document, in highly summarized form, the content of each lecture as it was given. It will be updated as each lecture is presented. It does NOT constitute a set of lecture notes. Please let me know if anything is incorrect or inconsistent.
Dr D Muir

15/1/15 Lecture 1 Introduction to the course

What these lectures are for:
- An accomplishment to the practical project work of the course.
- Some background and theory to illustrate the practical issues.

You will require to have, ‘at your fingertips’, all your other course materials and knowledge because we will need everything.

* Remember the Moodle site for the course where all the reference materials and copies of the handouts will be put.

Project work
- A great and interesting challenge
- Gives experience of design
- Teaches you to analyse the problem and hence break it down into manageable portions.
- Gives an appreciation that planning is important for a successful outcome.

Hopefully it will be great fun, especially when it all works at the end!

This year’s project – A lively display of pulse rate.

Start with the basic project diagram viz. sensor, process, display, PSU.
Break down the processing block further into: signal conditioning and micro.

Take each block in turn and look into its design.

Sensor – use an IR proximity detector.
Issues – pulse gives only a small signal ~3mv AC.
Micro needs 2-3 volts for a reliable input => need amplification.
Also filtering will be needed to remove high frequency noise.

Look at the basic Op Amp circuit.
Remember the calculation for gain
Note that the DC blocking, input capacitor forces a high pass on the system.
To filter out the higher frequency noise we need to include a low pass filter.

The Op Amp needs to work in the ‘single rail’ configuration’ which requires a $V_{ref}$ to be created for the $+Ve$ input to the amp. A potential divider is suitable but a filter capacitor needs to be included.
11/1/15 Lecture 2

Project planning
- The need to identify and plan tasks.
- Tasks depend on each other
- Each task has to be finished on time otherwise later ones get delayed.
- The plan is always being modified and updated to suit developments.
- Example task identification, simplest to work backwards from end point e.g.
  Debug PCB, depends on PCB layout, depends on footprints, depends on final schematic

Example plan as simple table formed of: Task, When, Who

Microprocessor and display boards.
  We will be using the Freedom MBed compatible board plugged into a breakout panel.
  Warning, be aware of the pin connections and the rows.

Display
  8x8 Led array – data sheet
  Multiplexing strategy for such displays, activate columns and drive the rows.
  Noted columns = Cathode, rows = Anode.

Maxim 7221 sheet
  Why device chosen – LED matrix drive capability
  - SPI communication.
  - Does its own multiplexing.
  - Sorts its own current drive.
  Overall function see the block diagram:
  Data word -> internal RAM -> display
  - data word is 16 bits long => 2 x SPI bytes.
  Note the instruction registers, intensity table, power down instructions etc.
  Note the decoupling capacitors required.

Display board
  Notice the 5V power requirement.
  Noted the 3v3 to 5v converter buffer chip.
Lecture 3
Reminder of project goals viz.
- Stand alone device showing a lively display of pulse rate – either as numerals and or as a ‘scope type’ running display. All on a PCB and running from batteries.

What size for the PCB? – guesstimate it – a tad bigger than the freedom + display board, just enough extra space for the analogue parts.

Decoupling capacitors:
What are they for:
- Take noise off power lines
- Beside every chip and also any analogue ones
- Values usually 0.1uF and of type multi layer ceramic.

Review of capacitor types, polarized/non polarized.
Polycarb, polyprop, tantalum, multi layer ceramic, electrolytic.
Some are good at high frequency performance, some bigger values, some more stable.
ESR – the capacitor equivalent circuit what it implies.

Hence choice of multi layer ceramic types for decouplers, since we don’t care about exact values.
Choose Electrolytic for low frequency decoupling.
Sometime specials needed e.g. Tantalum.
Voltage regulators often need tantalum types.
Note that decouplers are usually placed at every power pin of every digital device.
Remember that the display driver has special requirements.