Knowledge checklist
Here are list of questions covering the materials for each lecture. These are knowledge testers and are not tutorial questions as such. They give an indication of the level of knowledge and subjects which were presented in each lecture.
Dr D Muir

15/1/15 Lecture 1

What is this year’s project?
Can you draw a basic block diagram of the hardware of the project?
Describe the function of each of the system blocks: sensor, process, display, PSU.
What is signal conditioning?
How does the signal conditioning link between the sensor and the micro?
What does the signal conditioning do?
How does the sensor work?
What is an IR proximity detector?
What is the level of signal coming from the sensor?
What input signal level does the micro need?
Why is amplification necessary?
What extra features does the amplifier have to have?
What is the noise which will affect the sensor output?
What is the high frequency noise?
What frequency is the noise – and what might be causing it?
What is a basic OP Amp circuit?
How is the gain calculated?
What is a DC blocking capacitor and what is it for?
Give an example of the use of a DC blocking capacitor in the circuit.
Give the expression which allows you to calculate the corner frequency of the high pass filter.
Show how the DC blocking capacitor creates a high pass filter at the input.
Draw a circuit and show how to calculate a simple low pass filter.
What frequencies of high pass and low pass filters are needed in this project design?
What does ‘single rail operation’ mean when applied to an OP Amp circuit?
Draw a circuit of a simple Op Amp which is powered from a single rail.
Draw a suitable circuit for creating a Vref at mid voltage for use in an inverting Op Amp circuit to allow it to operate from a single rail. What values of resistor and capacitor are suitable for such a circuit?
Project planning – what is it?
Why is project planning needed?
What is a project plan?
What items are detailed on a project plan?

What microprocessor is to be used on the project?
What display is to be used in the project?
Draw the circuit of an 8x8 Led matrix.
What does common cathode mean?
Is the LED matrix used in the project common cathode or common anode?
Describe how multiplexing is used to drive all the 64 LEDs in an 8x8 array using only 16 wires.
What is multiplexing? Describe in what circumstances it is useful.
Describe a display driver chip you have used.
What is SPI and where is it used?
What signal lines does SPI use and what do they do?
Sketch a picture of the SPI signals as it transfers a byte of data.
What is the MISO connection?
What is the CS, Load or SS connection?
What is the SCK connection?
Describe how the display driver chip is organized so that it makes showing graphics on the Led matrix simple.
How much data is transferred between the micro and the display chip?
What is the structure of the data which is used to update the display registers?
What data rate is appropriate for the SPI to run?
If the display has to be fully updated 25 times a second, what is the minimum data rate needed on the SPI connection?
What challenges become apparent when a circuit is of mixed voltage?
What is the difference between 5V and 3v3 logic circuits?
How are signals on 3v3 logic transformed into those appropriate to 5v logic?
Why is a buffer chip necessary in the display breakout board?
Describe the function of the 74HCT04 in the display breakout board.
The SPI signals from the micro to the display chip are buffered using a 74HCT04 chip which is in fact an inverter. How is this possible?
Decoupling capacitors, what are they for?
Where are decoupling capacitors placed in the circuit?
Where are decoupling capacitors placed in the PCB layout?
What values are normally used for decoupling capacitors?
What types of capacitor are used for decoupling, and why?
Name a few types of capacitor.
What does polarized mean when talking about capacitors?
How do polarized capacitors differ from ‘normal’ ones?
Why are polarized capacitors useful?
What is ESR and how does it affect the use of a capacitor?
What capacitor types have good ESR?
In what situations are electrolytic capacitors used?
Why are electrolytic capacitors used?
What are the benefits of tantalum capacitors?
Describe some circumstances where Tantalum capacitors are important.
What are the deviations from perfect which cause real capacitors to be so different in practice?
Why should you use different colours of wire for different voltage levels
What type of wire would you use to connect the power supply
What risks should you be aware of and what safety precautions should you take.
What checks should you make before switching your circuit on?
If your circuit doesn't work, what steps would you take in your approach to fault finding?
How should your program code be broken up and why?
What considerations should be made when naming variables and functions?
How can you check if a function is being called without the use of a debugger?
How could you make your mbed switch between different modes, e.g. test mode and run mode.
Why is it better to keep a binary file as the test reference program?
What factors of the circuit affect the choice of battery?
How does the voltage from a battery change with time?
How do you calculate the effective resistance of a circuit which is the load for a battery?
Estimate the voltage and current requirements for the circuit being used in the project. Given the data sheet for the pp3, determine how long the battery will last if the circuit draws 50mA.
A circuit draws 150mA and the source voltage is 10V what is the effective resistance of the load?

In the Freedom power circuit describe the purpose of the diodes.
Can the power circuit for the Freedom board deliver 5V to an outside device.
What voltage is available from the USB socket?
What is the maximum current available for the 3v3 supply?

By reference to the data sheet for the display driver chip, determine the current required to drive the 8x8 LED matrix display.

What is a voltage regulator, what does it do?
Draw the basic application circuit for a linear voltage regulator.
Do the capacitors in the regulator circuit have to be of a certain value or type?
Using the data sheet for the LM3297 determine:
  Maximum and minimum input voltages.
  Maximum and minimum output currents.
  What does the minimum current value signify?
  What does the minimum input voltage signify?
  The dropout voltage.
Why does the dropout voltage matter?
What causes the dropout voltage?
Lecture 6

What is a heat sink? Why might it be needed?
Why might the regulator used in the project need a heat sink?
How do you calculate the power dissipated in the regulator?
What is the estimated value of power dumped in the regulator for the project?
Heat sink for the regulator for the project

What is the basic equation of heat flow?
What is the correspondence between Volts, Current and resistance and heat flow parameters?
What is a thermal resistance?
What units are used to express thermal resistance?
What is the driving force pushing heat out from the device?
What is ambient temperature?
Can you identify the thermal resistance between junction and ambient for the LM3297?
Can you discover the thermal resistance between junction and case for the LM3297?
What are the thermal parameters for the L78Sxx regulator?
Calculate the heat sink required if the LM3297 has to deliver full rated current from a 12V supply.
Can you look in the supply catalogues and choose a suitable heat sink?
19/2/15 Lecture 7

Logic families – what distinguishes them from each other?
- What is ttl?
  - What are the input voltage limits for logic high and logic low for ttl.
  - What are the output voltage levels for ttl?
  - How much current can ttl outputs provide – for logic high or logic low?
Can you sketch an outline circuit for a ttl gate so as to illustrate its input and output characteristics?
- What distinguishes ttl logic from CMOS logic?
- When it is said that CMOS logic output is ‘symmetrical’ what does that mean?
- What are the input and output voltage boundaries for CMOS logic levels?

What are the differences between 5V and 3V logic?
What is the difference between 74HCxx devices and 74HCT devices?

How can 5V logic circuits be interfaced to 3V logic circuits?
How can the output of a 3V logic device drive the input of a 5V device?
Can you sketch the circuit of an interface between the output of a 3V logic device and the input of a 5V device using a transistor as the active element in the converter?