Department of Electronic & Electrical Engineering

MEng/BEng in EEE/CES
CX/EE318 Engineering Project

This project planning is organised in five parts:

PART 1: PROJECT DESCRIPTION – including background, aims and objectives
PART 2: PROJECT WORK PLAN – including Gantt chart
PART 3: RESOURCE REQUIREMENT
PART 4: RISK ASSESSMENT
PART 5: CONDUCT & SAFETY DECLARATION & SIGNATURES

- All parts of the document must be completed jointly by the group members and a paper copy submitted at the start of the project presentation sessions (14th/15th Jan 2016). Bring to the presentation session.
- An e-copy of the document must be submitted on EE318 MyPlace page by 9.30 on 14th January 2016.
- The document should be completed by adding text and input where required.
- The completed document should be no longer than 8 pages of A4 – sections 1 and 2 are limited to 2 pages of A4 while sections 3, 4 and 5 are single pages.
- In addition to the submission of the planning document, each group is required to give a 10 minute presentation (followed by questions) to their project mentors and other student groups. The project presentation should be no longer than 4 Powerpoint slides and should summarise the salient points of the project planning to date.
- The document must be signed by all group members and all group members must attend and participate in the presentation and Q&A session.
- The project plan and presentation will be assessed by the group's mentor and a mark (worth 20% of the final group project mark) will be assigned.
- Each member of the group is advised to retain a copy of the completed form for reference and revision. This planning document should be included in the project logbook.

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Name (Group Member): CHENKAI WEI	Name (Group Member): JIACHENG SHI
Name (Group Member): YIHAN NIU	Name (Group Member): KONSTANTINOS KOSTOVASILIS
Project Team: GROUP 6	**Group Mentor:**
Project Title: SPEED DETECTOR	

PART 1: PROJECT DESCRIPTION

The purpose of this section is: (i) to provide a concise description of the project, and (ii) to state a set of objectives that will provide the guide for assessing the project. Students should note the importance of item (ii), which will be discussed in detail with their project mentors.

A. Project Description:

Introduction:

A speed detecting device is an important tool for metrology which is the science of accurate measurement. By knowing the speed of light it is possible to measure the distance over a certain period of time and thus derive the speed of the object under measurement. Such devices can be used for a number of different applications such as law enforcement, calibration purposes or accurately measuring distance for various purposes.

Background:

To measure speed of an object the Doppler Effect [1] can be used. A radio-wave antenna sends an ultrasonic sine wave (f_0) and depending on the frequency of the reflection (f) captured by the receiver the speed of an object (v_s) can be determined using Equation 1. With v_r being the speed of the receiver.

$$f = \left(\frac{(c - v_r)}{(c - v_s)}\right) * f_0 \quad (1)$$

One other way to measure speed is by using light and measuring the distance at two times. In theory the distance of an object can be found by calculating the time (t) it takes for light to reach it. By using Equation 2 the distance (d) can be calculated for the light to hit the object and return.

$$d = \frac{c * t}{2} \quad (2)$$

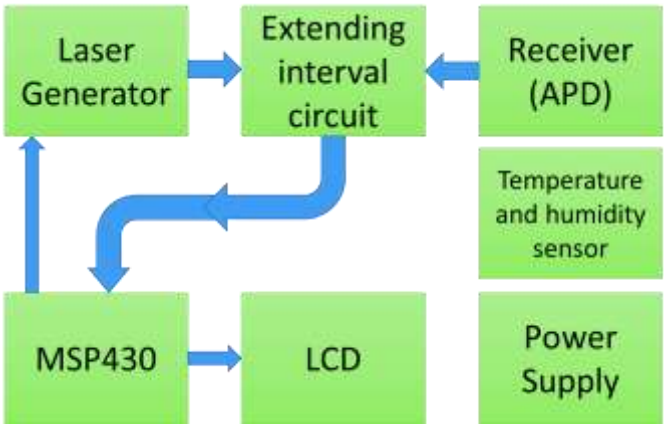
Aims:

The group aims to build a laser based speed detector. This was chosen because of the greater accuracy over the radio-waves one and higher measuring distance [2]. It is expected to be able to provide the user with four types of measurements, the instant speed, average speed and highest speed. In addition it will also display the distance of a moving or stationary object.

One other goal for the group is to all work together and manage to produce the device inside the time schedule. The project is compartmentalized and it is very important to manage and link all parts as time progresses as is for the final result.

Plan:

The completed device will transmit a pulse at specified intervals using a laser diode, the pulse will 'bounce' on the object and it will be captured by an Avalanche Photodiode (APD) [3]. In more detail a pulse will be produced by the software which will be amplified and then transmitted but also sent to charge a capacitor. On the receiving side the signal from the APD will be amplified and it will be used to trigger a switch which will close a circuit and make the capacitor to discharge.



The software will then record the time it takes for the capacitor to discharge, then it can be found for how long the initial pulse was charging the capacitor which will return the time it took for the signal to be received.

Secondary Plans:

The group understands that there are many ways the speed can be measured but most of these have the same basic elements. Some secondary plans will be developed during the second week of the assignment to allow an easy transition if something goes wrong which means that it is possible to change some parts but keeping others. It is assumed that the transmission and amplification for the laser diode will remain the same if the receiving method changes. Also for the software side most things will remain the same with a few changes in the calculations or how the data are used. It is fairly simple to change the method to take advantage of the Doppler Effect or just read the time of the returning signal by just having a trigger at the input.

Components:

Some key components are the MSP430 Development Kit which comes with the LCD to enable the projection of all the measurements, the Laser Diode [4] and the APD. The above are the main components for this project but also a number of transistors will be used to provide the correct amplification for the signals. A number of resistors and capacitors will be used to build the circuits and regulate the signals.

Hardware:

The hardware part is divided in three main parts. The first part will amplify the signal from the MSP430 board in order for the laser to transmit it, in addition it will also send it to charge the capacitor. The second part with the APD will receive the signal amplify it and trigger a switch which will enable the capacitor to discharge. The third and very important part is that of the supply which will have to be able to support the MSP430 board, the transmitter and the receiver modules.

Software:

The software is separated in two different modules. The first module will be providing the laser with a trigger (pulse) from the PWM output [5] on the board at specific intervals depending on the configuration of the boards output. On the receiving module the ADC input will start reading when the capacitor starts discharging and wait until it goes to zero. Knowing the clock for the ADC it is possible to record the time by adding for every iteration until it is zero.

It is very important to note that the frequency of the ADC must be at least twice that of the PWM output to make sure the recordings are accurate.

Testing:

One very important aspect for this project is the testing period. Tests will run while the different parts for the Software and Hardware progress. A signal generator and an oscilloscope will be used before both parts are put together. In addition for accuracy purposes there is going to be a calibration option on the device to allow the user to set the speed to zero or calibrate according to distance.

It is already known that all the speed measurement devices have errors in their readings. This can be due to environmental effects like temperature, humidity or wind [6], user error by not holding the ‘speed gun’ steady causing the ‘slip effect’ or if another object enters the line of sight of the one measured.

Extra Modules:

Some additions that will be added to the project if the group is on schedule will be a temperature measurement and a humidity measurement. These will provide a more accurate speed/distance reading by adding their inputs to the software calculations. A thermistor can be used for the temperature and a humistor for the humidity both in a simple bridge circuit or a digital combination of both. It will be important for these to be accurate and make sure that they don’t make the readings inaccurate.

References:

List all appropriate references cited in text above. See example

1. The Physics Classroom. ‘Waves - Lesson 3 - Behavior of Waves’. http://www.physicsclassroom.com/class/waves/Lesson-3/The-Doppler-Effect (accessed 10 January 2016).

2. Laser Technology, Inc. ‘TruSpeed Laser Speed Gun’. http://www.lasertech.com/TruSpeed-Laser-Speed-Gun.aspx (accessed 10 January 2016).

3. Dr. R. Paschotta.’ Avalanche Photodiodes’. https://www.rp-photonics.com/avalanche_photodiodes.html (accessed 11 January 2016).

4. Dr. R. Paschotta. ‘Laser Diodes’. https://www.rp-photonics.com/laser_diodes.html (accessed 11 January 2016).

5. Coder-Tronics. ‘MSP430 Timer PWM Tutorial’. http://coder-tronics.com/msp430-timer-pwm-tutorial/ (accessed 13 January 2016).

6. Donald P. Massa. ‘Acoustic/Ultrasound Choosing an Ultrasonic Sensor for Proximity or Distance Measurement’. http://tinyurl.com/6pjrfsm (accessed 13 January 2016).

B. Project Objectives:

Complete the table below to list the project objectives. These must be stated in such a way that they can be translated into achievable goals during the conduct of the project. For this reason, the stated objectives must be specific and realistic to be attained within the time provided. (Row can be added or deleted but this section is limited to no more than 1 page in length.

Project Objectives	Importance
Display instant/average/highest speed	HIGH
Display distance	HIGH
Allow option for calibrating the device	MEDIUM
Creating an appropriate casing with switches and buttons	MEDIUM
Adding extra modules for temperature and humidity and displaying it	LOW
Option to store average and highest speed for later use with a small menu	LOW

Add further rows if required

B. Project Deliverables:

Complete the table below to list the project deliverables in temporal order

Project Deliverables	Index
S/W: Manage to output the desired pulse from the MSP430 board. H/W: Have the amplifier ready for the laser to test the pulse.	1
S/W: Prepare the receiving side of MSP430 (Test with a signal generator). H/W: Complete the circuit with the photo-diode.	2
S/W: Combine the code to send and receive at the same time. H/W: Combine transmitter with receiver and test the supply.	3
S/W: Final testing with the software and hardware parts combined. H/W: Testing with software / Re-adjusting and fixing problems.	4
Extra work on both parts to add possibly more components and functions.	5

Add further rows if required

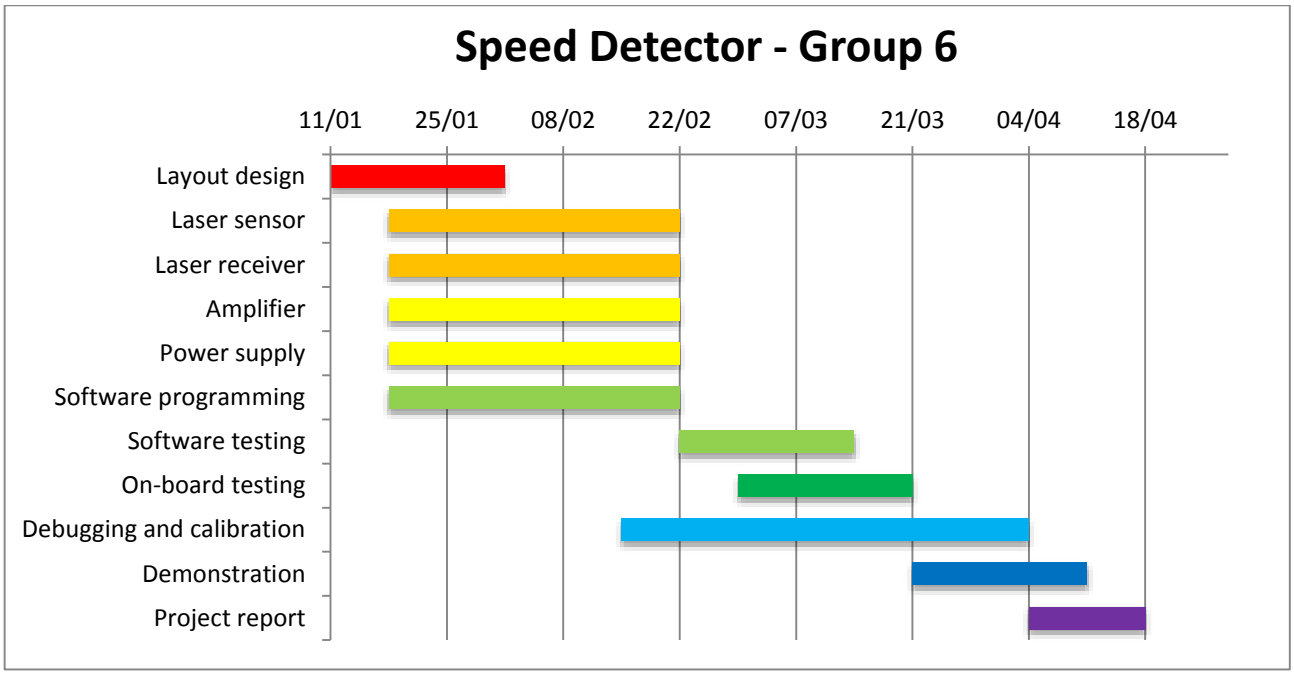
Add any additional explanatory text if required

PART 2: PROJECT RESPONSIBILITIES & WORK PLAN

In this section, the group is required to provide a project plan describing the tasks that need to be completed in this project, when they need to be completed and who is responsible for their completion. This section should take up no more than 2 pages of A4

A. Project Plan: Gantt Chart & Description

Provide a project plan in the form of a Gantt chart and accompany this with appropriate text to describe what each function is. The Gantt chart should indicate clearly the nature of the project tasks, its intended start and completion date as well as clearly showing the relationship between tasks and deliverables.



We start the layout design earlier than the hardware design, which gives an appropriate direction to this project. By the end of the hardware manufacture, we will begin the software programming and prepare to improve the hardware. The debugging and calibration will be kept through the on-board testing and demonstration to ensure the project works well. Finally, we will demonstrate the design and write the project report.

B. Project Responsibilities:

Against each group member, write down the project tasks for which they take prime responsibility and define the criticality (or importance of each task).

	Group Member	Tasks	Criticality (H, M, L)
1	Jiacheng Shi	Laser sensor	High
		Laser receiver	High
2	Chenkai Wei	Amplifier	High
		Power supply	High
3	Yihan Niu	Layout design	High
		Debugging and calibration	High
4	Konstantinos Kostovasilis	Software programming	High
		Software testing	High

PART 3: RESOURCE REQUIREMENTS

The following sections should be completed as part of the project planning. It is appreciated that to some extent it is not possible to exact when listing the requirements but at this early stage of the project it is critical to consider what the possible requirements are. This section will be judged upon its appropriateness rather than its exactness; it is expected that the requirements will change to some degree as the work progresses.

A. Equipment:

List the key hardware that will be used in this project – as well as the microcontroller board, list any other equipment that is essential to the completion of the project.

Microcontroller Board, Computer, Bread Board.

B. Components:

List the additional hardware components that are envisaged to be required: (resistors, capacitors, integrated circuits, cables etc. List values, catalogue part numbers, suppliers and approximate costs

Resistors, Capacitors, Diodes, Batteries, Inductors, Laser diode(808nm 300mW High Power Burning Infrared Laser diode, £1.09), APD(AD500-8 T05251, £10.90), Amplifier (OPAMP), Temperature and Humidity sensor(Sensirion SHT21, £2.81).

C. Technical Workshop Input:

List the expected input required in this project by the EEE workshop – list the function and the envisaged effort/time required. (Examples include PCB, fabrication, component ordering, drilling, soldering and construction.

Signal Generator, Oscilloscope, Probes, Multimeter, Amplifier, Soldering Iron

PART 4: TECHNICAL RISK

Management of project work requires that technical risk be assessed in advance, during initial planning and as an on-going process. As the first stage to this process, identify any aspects of risk associated with your project proposal. Risk in this context is taken to mean any event or action (or inaction) that would jeopardise any project outcomes or significantly impede project progress. Furthermore having identified such potential risks, indicate what actions you would take to mitigate the effects of this risk. (Examples of such risks include non-delivery of a key component, illness or absence from University, non-completion by student or other of key deliverable, equipment malfunction, extended learning curves- new techniques or software, etc).

	Possible Risk:	**Mitigating Action:**
1	Illness	Reserve some days in case of delay resulted from illness
2	Non-delivery of sensor	Two different plans were designed
3	Problems of hardware design	Use software to simulate design circuit first
4	Somebody cannot finish his part	Meetings are arranged regularly to exchange ideas and problems can be discussed together
5	Equipment malfunction	Use modularization and embedded system to minimise quantity of work

Students will be asked to reflect upon parts 1, 2 and 4 in the final report.

PART 5: SAFETY DECLARATION

All project students must be aware of the need for safe working during the conduct of their project. The Area Safety Regulations for the Department of Electronic and Electrical Engineering, which appear in the Undergraduate Handbook, provide general guidance. The project work will be carried out in normal working hours in the EEE Departments 4th floor Royal College labs and the hardware labs sited in the 7th floor of the Graham Hills Building. By signing at the end of this form, the project student is declaring that:

1. he/she has read and understood the Area Safety Regulations and will abide by these regulations during the conduct of the project, and
2. he/she will act responsibly, professionally and ethically during the period of the project, and
3. he/she recognises that this is a group project and that all group members share equal responsibility for meeting the deliverables associated with the project and for the return, in working condition, all hardware and equipment provided to support their group's project.

Signature of Student Date…….

Signature of Student Date…….

Signature of Student Date…….

Signature of Student Date…….