NATIONAL UNIVERSITY OF SINGAPORE

Department of Electrical and Computer Engineering

EE3032 PROJECT GUIDELINES FOR STUDENTS

1. INTRODUCTION

The EE3032 module aims to provide students with the learning experience of a typical embedded system development cycle. Students do a project in teams of three to four members each. The project will involve analog and digital hardware circuits, microcontroller (LPC1769) programming and system integration. A typical project comprises of the following tasks.

a) System specification development
b) Project scheduling
c) Paper design
d) Component selection and sourcing
e) Microcontroller programming
f) Breadboard prototyping
g) System integration
h) Printed Circuit Board (PCB) implementation
i) Product packaging
j) Final presentation and demonstration of working prototype
k) Documentation at every stage of the project

2. DESIGN CONSTRAINTS

The project will be conceived, designed, implemented and operated by the team. The team will aim at doing a useful and innovative project keeping the following constraints in mind.

Budget	S$500 (S$300 max internal components, S$200 max external purchase)
Time	8 weeks, each week about 15 hours of work per student on the project
Technology	The project must contain analog, digital hardware and LPC1769 microcontroller programming
Microcontroller	Maximum 2 LPC1769 microcontrollers
PCB	The final product prototype will be on PCB (Maximum size 6″x6″)
Prototype size	The final prototype must be less than 30cm x 30cm x 30cm
Teamwork	All team-members must be assigned reasonably equal amount of technical work towards the project

Starting with generation of ideas through brainstorming, the team will apply these constraints to shortlist ideas.

3. PROJECT EXECUTION

a. System specification development

Each team has to come up with the complete specification for their project. All the functional features, electrical and physical specifications should be set down for the entire system. The team should come up with block diagrams showing the subsystems with all input and output interfaces, such as inter-block connections, communications links and power supply distribution.

b. Project scheduling

The team shall prepare a project plan with smaller tasks and shall assign team members to execute them. By breaking down the complete project into smaller tasks and allocate time to complete each task in an organised manner, members can stay focused and work towards the deliverables and their respective deadlines. The teams should plan and come up with a project schedule in a GANTT charts (using MS EXCEL or any other software) and update them regularly.

A GANTT chart schedule example can be found at module homepage.

c. System design

Each team will start with a paper design showing the circuit schematics, process flow charts, design calculations, components selection etc.

d. Component selection and sourcing

After completing the design of all schematics, the next step is to source for the suitable components and test the circuits on bread-board.

Materials and Components:

Most standard components are available in the labs. The students are advised to approach the lab technician (LT) for any component they need. If the lab has stock, the students will just need to fill in the component record form accordingly and the item will be issued to them, with the cost of the item deducted from their team account. Otherwise, the students will be advised to purchase it from outside vendors, on their own.

Cost of components:

If students buy items from outside vendors, the cash receipts, the External Purchase Summary (EPS) form and the Request For Payment (RFP) form (both forms are downloadable from module homepage) must be signed by the PS. The cash receipts and the RFP form for each team may then be submitted to the ECE Finance Office (E4-07-15) for reimbursement. ***Each team of four may spend only $200 in this manner (i.e $50 per student).*** The total cost of items drawn from the lab must be $300 or less (i.e. $75 per student). Thus, the total cost of all components and materials used in your project must be less than $500 per team of four members ($375 for three-member-team, etc).

The total cost forms part of the project assessment. Penalty will be imposed on teams that draw/purchase components excessively without valid justification. Every member must maintain the Bill of Materials (lab and external) for the project.

e. Breadboard Prototype testing

Each team will construct the hardware circuitry on breadboard or veroboard and test it independently. Microcontroller i/o may be simulated at this stage, using switches and LEDs. The main objective here is to ensure that all the selected electronic components work together as planned and specified.

f. Microcontroller programming

The LPC1769 microcontroller can be programmed using Assembly language or C language. The programs are then compiled and the .hex file is loaded to the LPC1769 to perform all the tasks specified. The completed program should first be debugged and tested on the development board provided.

Visit the module homepage to download the LPCXpresso Integrated Development Environment.

g. PCB implementation

After breadboard prototyping is done, the circuits for the system have to be consolidated and implemented on PCB. PCB design can be done on the PCB design software, Altium Designer 6 (AD6), downloadable from the module homepage. An AD6 familiarization video and a library of the commonly used components used in this project are also available at the same site to allow the students to jumpstart. Other PCB related information is available at the PCB fabrication facility link on the homepage. Students are to use sockets for ICs and expensive components whenever possible. Students are strongly encouraged to include their team number, version number and date in their PCB layout for ease of identification.

Each team may use up to one A4 size of PCB. Extra PCB will be allowed only with the written permission of the PS. The cost of the extra PCB will be charged to the team's account

h. System integration and testing

With circuits on the PCB, the complete system is tested (debugged if necessary) to ensure it meets the specifications and objectives set down by the team.

i. Product packaging

Encasing the completed system in a suitable package gives the user access to controls and information intended by the team and conceals the operation mechanism to improve user-friendliness and ergonomics of the system.

j. Final Presentation

Each team will be given **at least 30 min for setup and exactly 30 min for the presentation cum demo** (20 min for the presentation/ demonstration and 10 min for the Q&A). The 20 min can be used to **introduce the project**, describe the **general features**, highlight the **main components** and **special features** through **block diagram/flow chart** of the algorithms used. There might be a **projector available** for the presentation slides and short pre-recorded videos. As for the 10 min Question

and Answer session, live demonstrations of **some or all features** (as determined by the examiners) may be needed along with replies to the technical questions posed. *Despite having pre-recorded the working features, it is still important to ensure all features are working properly on demo day as it still says a lot about the system's robustness.*

k. System documentation at every stage of the project

The aim of the Project Design Portfolio is to help students learn the value of good documentation. Each team will maintain a Project Design Portfolio for the project, by continuously filing the relevant documents as and when they are generated, on NUS Wiki. The Project Design Portfolio should contain the documents generated at every stage of the project:

- Ideas generated from brainstorming
- Initial System specifications
- GANTT chart and project task allocation
- Paper design: Circuit schematics, Flow charts, design calculations
- Subsystem Bill of Material with cost
- Picture of the completed breadboard prototype
- Final source code (for PIC, GUI, etc)
- PCB design art work and comments
- Picture of finished PCB prototype before modeling
- Picture of completed project
- Final System specifications, user manual
- Group meeting minutes, team communications
- Datasheets and reference documents
- One A4-page summary, outlines the project (300-400 words, with pictures)
- Personal learning journal (unlike all the above, every individual must prepare his/her own personal learning journal)

The Design Portfolio should be continuously evolving and should be updated on a weekly basis. **The softcopy of the one-A4-page-summary will be submitted via IVLE Workbin upload and as an attachment at Wiki at the end of the project**.

4. PROJECT EVALUATION

Evaluation of the project will be on a continuous basis in stages as shown in the following table. The criteria for assessment and the weightings are given in the **EE3032 Project Assessment Table**.

There are 3 continuous assessments (CA) in EE3032 project. The criteria for assessment are clearly defined along with corresponding weightings. The various grades for performance in these criteria are defined as **below average (<50%), average (50-64%), good (65-80%), very good (>80%)**.

Quality Assurance in EE3032 project assessment:

The whole class is divided into two or three groups, with each group being under direct supervision of one Project Supervisor (PS). Each PS carries out the assessments for CA1 and CA2. The Project Mentors (PM) cross-check these assessments and moderate them as necessary.

The CA3, which involves the final project presentation, is done by a panel of examiners consisting of all the PS and PM. Each team is allotted 30 minutes to setup their system, followed by 30 minutes for presentation. The final CA3 score for each team is obtained by averaging the scores given by each examiner.

The CA2 and CA3 scores for each student based on his/her team score and

1. Peer feedback from the team members
2. Project Supervisor's feedback
3. Personal learning journal

EE3032 Project Assessment Table

MLOs	Stages & Deliverables	Individual Marks	Team Marks	Lab Session	Weight (%)
CA1: ISS Report & Quiz					
1,7	Initial system specifications, Gantt chart, resource allocation, paper design – system block diagrams, circuit schematics & process flow charts	-	5	2	25
4	Technical Quiz	20	-	6	
CA2: Project implementation					
3, 4, 7	Breadboard prototyping and coding	25	-	3 - 6	35
2	Concept of design excellence -- effectiveness & efficiency, considering non-engineering impacts (CODE)	5	-	3	
3	Proof/Implementation of design excellence (*together with CODE)			5 - 7	
3, 4, 7	PCB design and wiring	-	5	11	
CA3: Demonstration & Documentation					
1, 3, 4, 9	Final demonstration 1. Hardware & software implementation 2. Design & integration 3. Project specific criteria 4. Project presentation	-	30	13	40
8	Project documentation	-	10	13	
	Subtotal:	50	50	**Total:**	100

5	Lab and module safety awareness *(Satisfactory/Unsatisfactory, not graded)*	
6	Effectiveness as a team member *(Satisfactory/Unsatisfactory, not graded)*	