Theme Based Course Projects for Digital Electronics Course

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Abstract: All most all modern electronics devices such as smart phones and laptops depend on concepts derived from digital electronics. In fact, most electronics about the industry and in home depend on digital electronics to work. To consider for forth coming semesters digital electronics course is prerequisite for the courses such as Digital system design using Verilog, mini projects, ARM Controller (3rd year), VLSI Design and Capstone project (4th year). And it plays very vital role in placement activities and competitive exams. To make this course more interesting and to increase the level of understating we designed the course project keeping automotive as the theme which indeed helped the students to understand the application point of view of the concepts studied in the course. We are presenting the Course projects designed, effectiveness of the Course Project on Final results and attainment of the program outcomes with different levels of competency for the Digital Electronics course in the 2nd year UG Engineering.

Keywords: ABET, Program outcomes, Bloom's taxonomy, Digital Electronics, course project, automotive electronics

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1. Introduction

This is core course of instrumentation technology department that presents basic tools for the design of digital circuits. It serves as a building block in many disciplines that utilize data of digital nature like digital control, data communication, digital computers etc. The goal of this course is to;

1. Understanding the different logic families and how factors such as fan-out considerations, fan in, propagation delay and timing analysis affect the design.
2. Manipulate Boolean algebraic structures.
3. Simplify the Boolean expressions using Karnaugh Map, QM Method and Decimal Method.
4. Analyze and design various combinational logic circuits.
5. Understand the basic functions of flip-flops and use of flip flops in design of shift registers and counters.
6. Analyze and design clocked sequential circuits.
7. Understand the importance of state diagram representation of sequential circuits.

This course makes significant contributions to the following program outcomes:

- an ability to apply knowledge of mathematics, science, and engineering,
- an ability to design and conduct experiments, as well as to analyze and interpret data,
- an ability to design a system, component , or process to meet desired needs within realistic constraints.
- an ability to identify, formulate, and solve engineering problems,
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Automotive electronics is a sub-system consisting mainly of semiconductor devices used to sense, compute and actuate the different features/functions in a car. It is interesting to note that electronics in today's car already

exceed 20% of the total vehicle value and this is estimated to increase to 35% within the next 6 years. The majority of automotive innovations will be driven by electronics innovations enabled by semiconductors. By seeing all these opportunities theme for the course project was decided as automotive electronics.

Organization of the rest of the paper is as follows Section II deals with enhanced learning process, section III discusses about implementation details and assessment, effectiveness of the activity in section IV, section V discusses the experimental outcomes (ABET a-k). Finally the results and conclusion are discussed in section VI.

2. LEARNING PROCESS

The details of the course project are presented in this section. The course activity involves the following

- Preliminary design
    1. Ensure that all system requirements have been allocated, the requirements are complete, and the flow down is adequate to verify system performance.
    2. Show that the proposed design is expected to meet the functional and performance requirements.
    3. Show sufficient maturity in the proposed design approach to proceed to final design.
    4. Show that the design is verifiable and that the risks have been identified, characterized.
- Concept level design
    1. Clearly and efficiently present three concepts, which your team has determined to best, meet the requirements of the project.
    2. Show on paper design with all the specifications
- Simulation and implementation results
    1. Use of the modern engineering tool to verify the schematics level implementation
    2. Finally prepare the PCB for demonstration and prototyping
- Extended learning:

  Focuses on core academic learning with detailed qualitative analysis which in turn leads to scope for improvement beyond curriculum
- Report writing:

  Information collected is organized for meaningful interpretation and analysis and submitted in the form of report, reflecting all the activity details including the simulation and implemented snaps/videos of the course project using given template.

First course project helps students to use concepts studied in the digital electronics course mainly focuses on Timer circuits, Flip Flops, counter design and Gates. Time scale were given different for each batches.

Problem statement 1:

Design a logic circuit to sense accelerator pedal to detect high speed & a warning system if accelerator pedal is pressed by the driver continuously for _ _ _ _ _ seconds. (Assume a potentiometer for accelerator pedal).

Second course project helps students to use concepts studied in the digital electronics course mainly focuses on switch debouncer circuit, Timer circuits, Flip Flops, counter design and Gates. Time scale were given different for each batches.

Problem statement 2:

Design & develop a logic circuit for interior lightening of car. Lights have to be turned off _____ seconds after closing the door.

Third course project helps students to use concepts studied in the digital electronics course mainly focuses on Decoder circuit design, seven segment display and Gates.

Problem statement 3:

Design a battery level indicator system using different logic components. Display the characters "FULL" using 4 seven segment display.

Fourth course project helps students to use concepts studied in the digital electronics course mainly focuses on combinational circuit design, switch debouncer circuit, Timer circuits, Flip Flops and Gates. Time scale were given different for each batches.

Problem statement 4:

Design & develop ignition distribution circuit for four cylinder engine. For every_____ seconds one cylinder has to ignite sequentially.

Fifth and last course project helps students to use concepts studied in the digital electronics course mainly focuses switch debouncer circuit, Timer circuits, Flip Flops, Johnson / ring counter design and Gates.

Problem statement 5:

Design car direction indicator system for the following specifications

- *Indicate left(L) & right(R) turn using set of LED's (minimum 4 LED for each direction)*
- *When left/right button is pressed the LED should be turned on in sequence for R to L or L to R respectively.*

3. IMPLEMENTATION

This section deals with the details of process execution and assessment methodologies.

A. Process execution

Execution of the course project involves the following various stages

Team formation: groups were formed comprising four students in each team and team leader was identified. Roles and responsibilities of each students were also defined. Team leader has to coordinate, plan, organize and track the activities within a team. Each and every role within a team was accountable.

Course project assigning and understanding: once team formation was done each team was assigned with one course project depending on the lab batches, 5 lab batches 5 different problem statements. The students have to make a thorough study of the problem and understand how it can be implemented using the conceptual knowledge gained through course.

Demonstration: students have to effectively demonstrate their simulation and implementation results, every team have to prepare snaps/videos demonstrating the working prototype model of the process.

Fig. shows the sample implemented prototypes developed during their third semester as course project

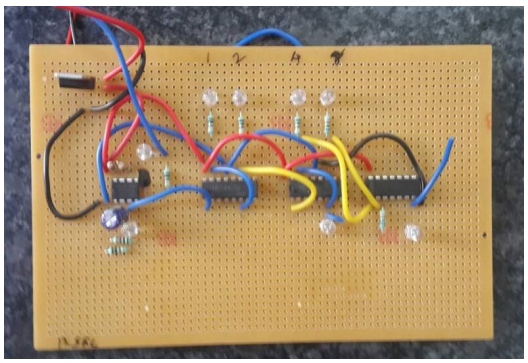

Fig.1. Design of Accelerator Pedal

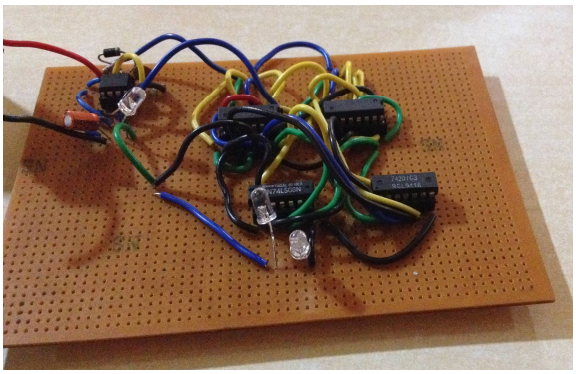

Fig.2. Design of Ignition Distribution

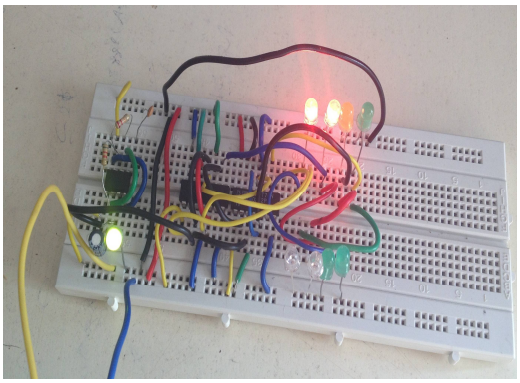

Fig.3. Design of Car Indicator

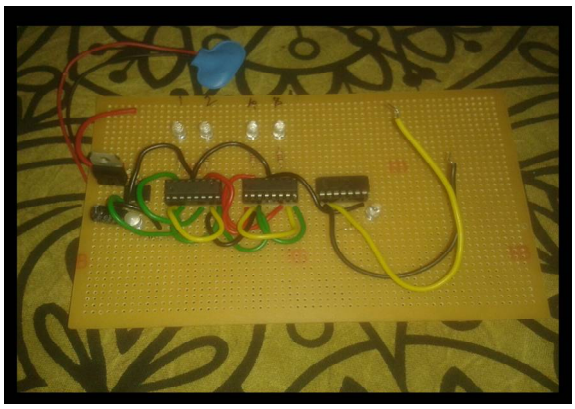

Fig.4. Design of Interior lightening of car

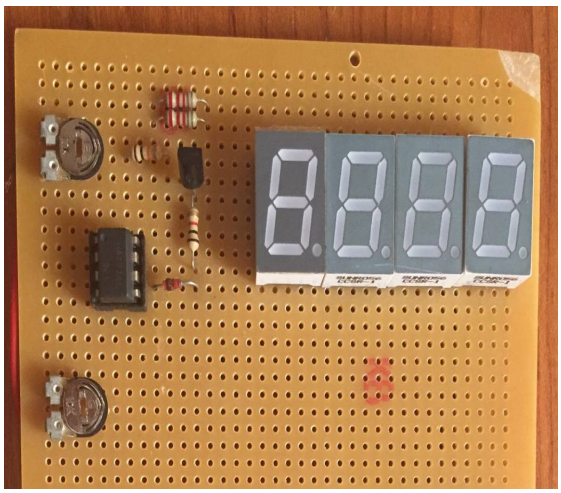

Fig.5. Design of battery level indicator

B. Assessment

Method of assessing the effectiveness of activity includes student performance assessment, student self-assessment and student feedback. Contributions to the activity can be assessed in terms of individual deliverables and group deliverables. The assessment metric/rubric for evaluating the performance of the students is show in table I.

Table I assessment criteria

Sl.No	Assessment creteria	weightage

1	Preliminary design	20%
2	Concept level design	20%
3	Implementation • Simulation results • PCB	 20% 20%
4	Demonstarion & Report writing	20%

4. EFFECTIVENESS OF COURSE PROJECT

The effectiveness of the activityreflected in the following ways.

A. Reflections of course project through continous monitoring and feedback.

Assessment based on student feedback has been collected by each team and gives the statitics of achievement of 96% is observed to justify the learning beyond curriculum as shown in column 1 of fig 6. Question 3 and 4 related to comfortably working with digital electronics concepts shows 84% of the students could find it easy and comfortable to work with digital electronics and explore it beyond curriculum for real time automotive applications as shown in column 2 of fig 5. Question 8 & 9 related to improving soft skills and 72% students express as their presenation skills are improved, 45% students, express as their leadership qualities are enhanced, 46% students express as their verbal communication has improved and 69% students express as their organizing skills have improved as shown in fig 7.

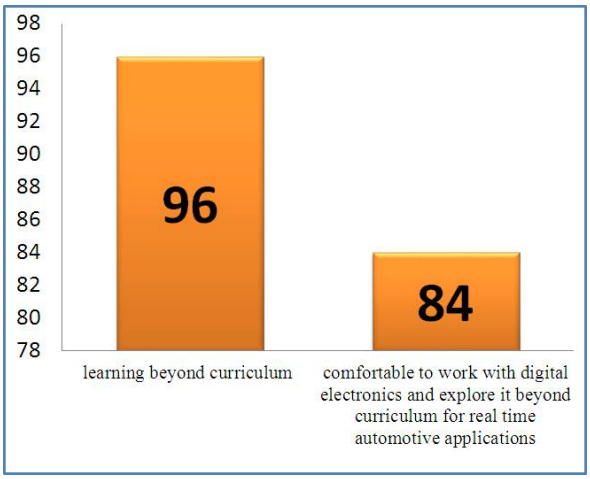

Fig.6 Feedback questionnaire response for Q1,7 &3,4

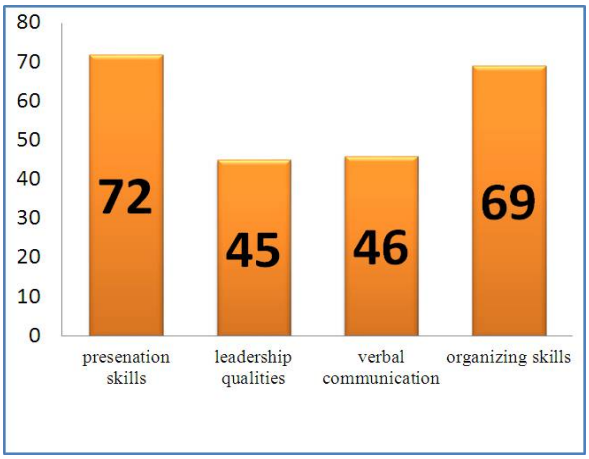

Fig.7 Feedback questionnaire response for Q8 & 9

B. Reflections of course project in Semester end examamination (SEE)

The effectiveness of the activity proposal has been reflected in the performance of students in semester end examination (SEE), where they are exposed to higher levels (L3) of learning as per Bloom's taxonomy[8][10]. The performance of the SEE results for the said subject in the present acadamic year (2014) is compared with the previous acadmic year (2013) as show in the fig 8. An improvement of 30% is observed in number of S grades while an improvement of 34% is observed in number of A grades.

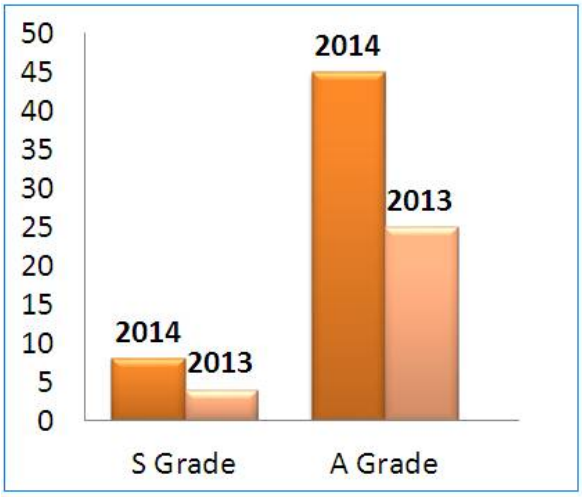

Fig.8 Comparison of results

5. EXPERIMENTAL OUTCOMES AND DISCUSSION

The effectiveness of the course project as a part of a core subject in the identified theme is mapped to the program outcomes a to k of accreditation board for engineering and technology (ABET)[2] criteria as shown in table II.

Table II. Activity outcomes mapping to ABET program outcomes

Performance indicators of course project	PO-PI

	assessed
Performance need & market analysis	
Team formation and defining the roles	d-1A d-1D
Requirement analysis	c-1A
Ability to identify limitations, constraints and assumptions based on available resources.	c-2C
Derive the requirements	
Ability to develop the circuit/algorithm	c-4A
Perform functional analysis	
Ability to develop system functional block.	c-5A
choose the proper simulation and modeling tool for functional verification of circuits/system	c-5B
Ability to verify the desired functionality	c-5C
Conceptualization & evaluating alternatives	
Performance indicators of course project	**PO-PI assessed**
Ability to develop a circuit/algorithm	c-4A
Ability to verify the desired functionality	c-4B
Ability to explore different approaches to solve the defined problem by carrying out literature survey	c-3A
Ability to compare the limitations and advantages of alternative approaches and choose the suitable one	c-3B
Ability to identify limitations, constraints and assumptions based on available resources	c-2C
Awareness about the importance of learning beyond curriculum using technical library resources, interacting with experts and participating in technical events	i-1A
Embodiment design	
Ability to validate the obtained results	i-1A
Ability to use EDA tools for modeling and simulation	c-5B
Detailed analysis and simulation	
Choose the proper simulation and modeling tool for functional verification of circuits/system	k-4A
Prototype development & final presentation	
Ability to verify the desired functionality	g-1A
Ability to write clear and well organized project reports	g-2A

The said course without presently adopted pedagogical techniques addressed only and g in previous academic years while through this activity along with a and g, c, d, I, k, were also addressed and attainment is as shown in fig 9

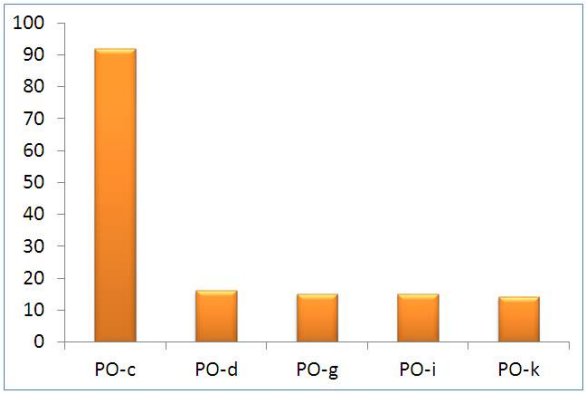

Fig.9 PO attainment for the digital electronic course

6. CONCLUSION

This paper presents the design, delivery and assessment of a course activity for the course digital electronics students at 3rd semester, the activity designed strengthened digital electronics course by enhancing the learning. The metrics and the techniques adopted for the assessment of the learning outcome have been listed and the results are presented. The overall outcome as seen from the result analysis clearly indicates that the approach adopted has indeed significantly been encouraging in terms of the holistic student development.

The most prominent positive outcome of the experiment is that over 90% of the students have clearly indicated that this has given them a very good opportunity to evaluate, work on and improve their verbal as well as written communication skills apart from helping them in connecting the theoretical concepts to practical applications.

This is to observe that the innovative approach adopted has indeed significantly effective in improving the overall teaching learning process, encouraging the teachers and students to extend the same to the relevant courses in the curricular program and also identified problem definitions can be taken up as a min/minor project in coming semester.

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