"Product Development" –A New Learning in Open Ended Experiment

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Abstract

Nowadays many educational institutions are adopting outcome based education system, wherein active participation and learning of students is involved. This paper reports OBE based learning experience as a part of laboratory experiments in the field of analog electronics at 3rd semester. Theory of analog electronic circuits will be well understood only if students conduct series of experiments from simple to complex circuits using various analog components. Also, if students are taught to develop small products at primitive level, it will help them to carry projects till product realization in higher semesters. This motivated us to keep product development exercise as a part of open ended category along with generating a datasheet for the said product, which requires active learning and involvement of the students throughout the development life cycle of a product. This paper presents the experiential learning in developing 5V power supply as a part of open ended experiment. This helped students not only to understand the product design cycle and also helped to improve their circuit debugging skills as well as in designing PCB's along with generating data sheet for a given specifications at 3rd semester level.

Key words: Open Ended Experiment**,** PCB, Product Development, and Datasheet.

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1 Introduction

Analog electronics systems are electronic systems with a continuously variable signal, in contrast to digital electronics systems where signals usually take only two levels 'zero' and 'one'. The term "analog" describes the proportional relationship between a signal and a voltage or current that represents the signal. Analog electronic circuits are different from digital circuits, in that the signals are expected to have any value rather than two discrete values. In general, electronic systems tend to be made up of combining range of simpler elements, components and circuits of various kinds. Primitive analog components include the diode, MOSFET, BJT, resistor, capacitor, etc. Analog circuit building blocks include single stage amplifiers, differential amplifiers, constant current sources, voltage references, etc. Basic analog electronic ciruits include the operational amplifier, inverting amplifier, non-inverting amplifier, integrator, bistable multivibrator, peak detector, comparator, RC oscillator, etc. Mixed-mode analog integrated circuits include Digital to Analog converter, and Analog to Digital converter etc .

Continuous Quality Improvement (CQI) in engineering education plays very important role in making students more competitive and knowledgeable. OBE is an education process that focuses on achieving a particular outcome or skill that should be grasped by each student at the end of the course [2]. In general the OBE assessment includes Course Outcomes (CO), Program Outcomes (PO) and Program Educational Objectives (PEO) which are defined below.

Programme Educational Objectives (PEOs)
– Programme educational objectives are broad statements that describe the career and professional accomplishments that the programme is preparing graduates to achieve.

Programme Outcomes (POs)

– Programme Outcomes are narrower statements that describe what students are expected to know and be able to do upon the graduation. These relate to the skills, knowledge, and behavior that students acquire in their matriculation through the programme.

Course Outcomes (COs)

-- Course Outcomes are narrower statements that describe what students are expected to know, and be able to do at the end of each course. These 10 relate to the skills, knowledge, and behaviour that students acquire in their matriculation through the course.

Assessment

– Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of programme educational objectives and programme outcomes.

Evaluation

– Evaluation is one or more processes, done by the evaluation team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which programme educational objectives or programme outcomes are being achieved, and results in decisions and actions to improve the programme.

Mapping

– Mapping is the process of representing, preferably in matrix form, the correlation among the parameters. It may be done for one to many, many to one, and many to many parameters [1].

It means that in OBE, each student should be able to achieve the stated CO, PO and PEO or corresponding skill level. PEO'S defined at our institution are as follows and Table 1 shows the PO's set for Electronics and Communication Engineering.

The graduates of E&C Programme will be able to

1. Pursue successful careers in industry, academia and entrepreneurial ventures in the domain of Electronics and Communication.
2. Innovate, design, evaluate and maintain products/processes for offering solutions to real life problems.
3. Pursue higher education, engage in research & development activity and add value to the organization by continuous learning.
4. Exercise excellent leadership qualities in a responsive, ethical and professional manner for socio economic growth.

Table 1:Program Outcomes For Electronics & Communication Engineering

POs	Abet a-k
PO1	Apply math, science & engineering
PO2	Design & conduct experiments
PO3	Design a system, component and process
PO4	Function on multidisciplinary teams
PO5	Identify, formulate & solve eng. Prob.
PO6	Professional & ethical responsibility
PO7	Communicate effectively
PO8	Impact of engineering Solutions
PO9	Lifelong learning
PO10	Contemporary issues
PO11	Modern engineering tools

2 Implementation Details of Open Ended Experiment

To understand the subject in a better way and to enhance student's design and debugging skills, product development of 5V, 1A power supply along with data sheet generation was given as part of open ended experiment. Students were given two lab slots to carry out the open ended experiment.

Methodlogy followed by students to develop the product is shown in fig 1.

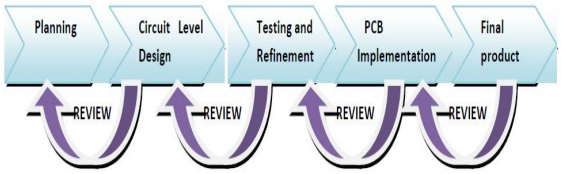

Fig. 1: Methodology [3]

Students started exploring different circuits available along with protection circuits, to arrive at desired specification. Students carried out the experiment in different phases such as design of circuit, circuit simulation, bread board implementation, testing and PCB implementation (soldering on Dot Matrix board or on PCB) and casing. Once final product is tested , students were asked to generate datasheet for their product.

Need for Datasheet: A datasheet is a document that summarizes the performance and other technical characteristics of a product, component (e.g., an electronic component), material, a subsystem (e.g., a power supply) or software in sufficient detail to be used by a design engineer to integrate the component into a system. Typically, a datasheet is created by the component/subsystem/software manufacturer and begins with an introductory page describing the rest of the document, followed by listings of specific characteristics, with further information on the connectivity of the devices. Depending on the specific purpose, a datasheet may offer an average value, a typical value, a typical range, engineering tolerances, or a nominal value. The type and source of data are usually stated on the datasheet. A datasheet is usually used for technical communication to describe technical characteristics of an item or product [4]. This will help the students to know about characteristics of particular components/product and also appreciate the use of referring datasheets in carrying out projects in higher semesters.

2.1 Sample Data Sheet

General Description

In most of our electronic products or projects we need power supply for converting mains AC voltage to regulated DC voltage. LM7805 is been used as voltage regulator in our device. The device takes input AC voltage of 220-280V and gives output of 5V regulated DC. The device is compact and portable which makes it preferable.

The components and IC's used are of high efficiency, hence the overall efficiency of product is greater than 90%.

Features

- Vcc=5v ±0.4% (T=25C).
- Current 1A.
- Input voltage range 220-280v, 50Hz.
- Efficiency > 90%.
- Cost effective circuit.
- Portable.
- Light weight.
- Compact.

Circuit Diagram

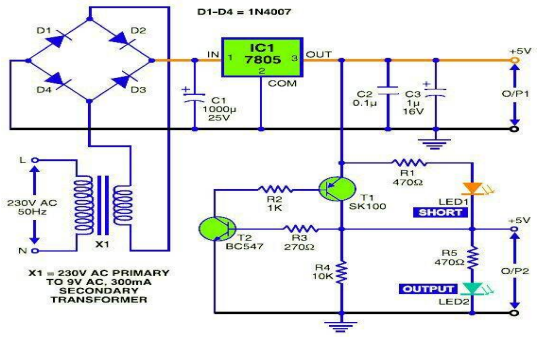

Fig. 2: Circuit Details

Absolute Maximum Rating

- Input voltage range 220v-280v(50Hz)
- Input current 100mA-1A
- Output voltage range 4.6v-5.5v
- Working temperature 0-150 °C

Physical Dimensions

- Length = 15 cm
- Breadth = 8.5 cm
- Height = 5.5 cm

Applications

- Local 220v to 5v conversion.
- Microprocessor daughter boards.
- Precision control circuits.
- Research projects.
- TTL circuit power.

Final Product

Fig. 3: DC Power supply

Fig. 4: Different Products view

3 Assessment and Evaluation

Following are the course learning outcomes set for the Analog electronics lab and Table 2 shows the mapping with PO's.

Course Learning Outcomes-CLO

At the end of the course students will be able to:

1. Realize the system such as clipper, clamper and amplifier etc for the given specifications by choosing appropriate electronic device.
2. Conduct an experiment and analyze the experimental results to determine the relevant performance parameters of a given amplifier circuit using BJT/MOSFET.
3. Conduct an experiment to determine the efficiency of a push-pull amplifier.
4. Design and implement basic analog functional unit.

Table 2: **Mapping of Course Learning Outcomes (CLO) with Program outcomes**

Course Learning Outcomes-CLO	**a** Apply math, science & engineering	**b** Design & conduct experiments	**c** Design a system, component
1. Realize the system such as clipper, clamper and amplifier etc for the given specifications by choosing appropriate electronic device.		**H**	
2. Conduct an experiment and analyze the experimental results to determine the relevant performance parameters of a given amplifier circuit using BJT/MOSFET.		**H**	
3. Conduct an experiment to determine the efficiency of a push-pull amplifier.		**H**	
4. Design and implement basic analog functional unit.			L

The attainment of POs may be assessed by direct and indirect methods. Direct methods of assessment are essentially accomplished by the direct examination or observation of students' knowledge or skills against measurable performance indicators. Rubric is a useful tool for indirect assessment. A rubric basically articulates the expectations for students' performance. It is a set of criteria for assessing students' work or performance. Rubric is particularly suited to programme outcomes that are complex [1]. Table 3 shows the performance indicators followed for the evaluation and the corresponding Rubrics are defined in Table 4

Table 3: Program Outcome elements addressed in the Course and corresponding Performance Indicators

Outcome Element:	**Ability to conduct experiments**
PI Code	PI
ECOE(b)-2A	Ability to conduct a laboratory procedure with minimal supervision
ECOE(b)-2B	Demonstrate ability to determine performance parameters.
Outcome Element:	**Ability to analyze and interpret data**
PI Code	PI
ECOE(b)-3A	Ability to analyze the observed tabulated data
ECOE(b)-3B	Ability to Interpret the results using relevant theoretical background.
ECOE(b)-3C	Ability to Verify and conclude experimental results

Table. 4: Assessment Rubrics

Build analog functional block to meet given requirements.	
Ability to identify the input parameters and design Weightage (40)	ECOE(b)-1,2
• Identifying multiple solutions • Decide the type of circuit to be used for the given application. • Design the circuit for required specifications. • Apply theoretical concepts to design an experiments	
Ability to conduct experiments Weightage (40)	ECOE(b)-2
• Perform simulation using appropriate tools, and select the optimised solution • Ability to inplement the optimised solution	
Results and analysis Weightage (20)	ECOE(b)-3
• Intrpret the results using relevent thereotical background	

3.2 Result and Discussions

The performance evaluation is done by using the rubrics shown in Table 4. Each student is evaluated for 100 marks as a part of CIE (Continous Internal Evaluation) and the sample result of 15 students is shown in figure 5. The students were asked to demonstarate their product with proper casing along with data sheet.

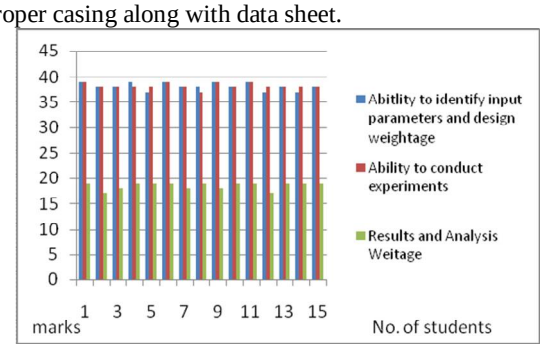

Fig. 5: Assessment

3.3 Feedback Analysis

Set of questions were given to students to report and analyze their learing skills through this open ended product development exercise. Table 2 shows the feedback questions used for student's feedabck. Figure 6 shows the feedback analysis for a sample set of 10 students as shown in figure 6, the student's performance in debugging the circuits is quite low compare to the other mentioned parameters.

Table 2:Feedback Questionnaire

Q2.	SA				SD
	1	2	3	4	5
1. The Open ended experiment improved my Debugging skills.	○	○	○	○	○
2. The Open ended experiment improved my Technical skills.	○	○	○	○	○
3. The Open ended experiment increased my confidence level in handling analog circuits.	○	○	○	○	○
4. The Open ended experiment improved my Product development skills.	○	○	○	○	○
5. The Open ended experiment improved my PCB Design skills.	○	○	○	○	○
6. I have the confidence to use the knowledge gained from the Open ended experiment in my life.	○	○	○	○	○

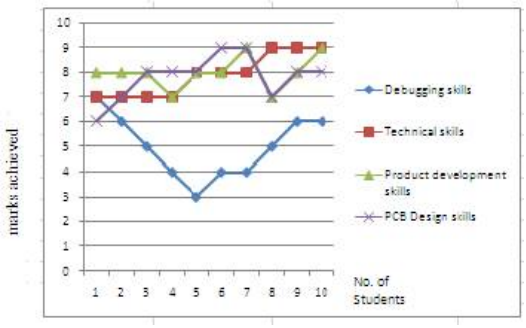

Fig. 6: Feedback analysis

Conclusion

OBE helps in improving the quality of education in engineering and which is must for current scenario. Rubrics are designed to study the level of each student from all aspects of engineering. The theoretical concepts and circuit simulation using tool which were discussed are well demonstrated through model/product building in the open ended experiment. This intern helped students to improve their technical, debugging skills and also how to prepare data sheet of given system/product. Students have justified that any theory related problems are better structured through implementations. It also helped students to expose and familiarize with a team based working environment. From the observation by conducting this type of open ended experiment, we can say that independent learning can be enhanced amongst the students.

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