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An Innovative Interdisciplinary Teaching and Learning Methodology for Outcome Based Education

M Rajendra Prasasd[1]
[1]Department of Electronics and Communication Engineering, Vidya Jyothi Institute of Technology, Hyderabad
[1]rajendraprasad@vjit.ac.in

Abstract: The Outcome-Based Education (OBE) is a scholastic method that emphasizes on what students can learn after the completion of their course or programme. Today exploring different ideas and innovation of new techniques at inter-disciplinary areas are mandatory for a fresh engineering graduate. OBE is an active learning- teaching methodology providing solution for the above problem. The courses relating to different disciplines are integrated together to implement different innovative ideas in the area of engineering education. An Innovative Interdisciplinary Teaching and Learning Methodology (IDTLM) is essential in the area of Electronics and Computer Engineering Education at under graduate level or any other engineering area. This paper describes about the procedure to develop IDTLM and is successfully implemented for interdisciplinary courses like Operating System and Embedded System courses for engineering graduates at Vidya Jyothi Institute of Technology, Hyderabad. This paper presents the process of implementation of IDTLM for different engineering courses and how it is useful to develop course/open-ended/academic/in-house/mini/major projects in the area of Electronics and Communication Engineering Education. This paper also explores the effective usage of IDTLM with the case study results and is compared with benefits over the Conventional Methodology (CM). The result shows the better attainment values for Course Outcomes (COS) and Program Outcomes (POS) achieved using IDTLM in OBE implementation.

Keywords: Outcome-Based Education (OBE), Interdisciplinary Teaching and Learning Methodology (IDTM), Interdisciplinary Courses, Program Outcomes, Course Outcomes, Electronics and Communication Engineering Education.

M Rajendra Prasasd
Department of Electronics and Communication Engineering,
Vidya Jyothi Institute of Technology, Hyderabad
rajendraprasad@vjit.ac.in

1. Introduction

OBE recently has become a focus in learning-teaching enhancement in the field of engineering education system all over the globe. The motivation towards OBE implementation has been supported by most academic institution, which offers engineering courses in India and abroad. The process of execution of OBE is not an easy task, it requires a lot of effort to design Program Educational Objectives (PEOs) after defining the Vision and Mission of the Department, which is derived from the Institute's Vision, and Mission. POs are narrower statements that describe what students are expected to know and be able to do after completion of the course or program. COs are student focused and these are specific enough to be measurable and to attain the abilities to the central discipline of the program. In this paper Outcome-based approach is designed for engineering education and discussed an innovative interdisciplinary methodology is developed and implemented

successfully for various courses in the area of Electronics and Computer Engineering Education for not only effective attainment of COS and POS also for execution of course/open-ended/academic/in-house/mini/major projects at Department of ECE, Vidya Jyothi Institute of Technology, Hyderabad, India.

2. Literature Review and Related Work

Rubýn Sýnchez-Dams proposes methodology with practical approach for creating theories related to computing for embedded systems [1]. M.Rajendra Prasad implemented project based teaching methodology for embedded engineering education for effective attainment [2]. Holliger & W. Elspass presented Project Oriented Learning Environment (POLE) to innovative design and practice interdisciplinary practice for technical students [3]. M.Rajendra Prasad explained the methodology to implement a Computer based teaching Methodology (CBTM) for different engineering education courses and how it is useful to develop applications or projects in the area of Electronics and Computer Engineering Education [4].This paper describes the procedure to develop an interdisciplinary teaching methodology for two or more courses in engineering education at Department of ECE, Vidya Jyothi Institute of Technology, Hyderabad, India.

3. Modelling of Outcome-Based Education

Modeling of Outcome-Based Education at Electronics and Communication Engineering Department, Vidya Jyothi Institute of Technology, Hyderabad is shown in the figure 1. The institute's Vision and Mission statements are circulated to all the stake holders such as Employers, Alumni, Industry, Senior students, Faculty, Professional Bodies and Department Advisory Board, seeking their views, opinions and comments for defining the Vision and Mission of the department [5].

Thereby collecting the inputs from above mentioned, the Program Assessment and Evaluation Committee (PA&EC) committee in co-ordination with programme co-coordinator will discuss keeping in view the present trends in the development of this profession, requirements of industry, society and future data related to Electronics and Communication [6]. The development process of Vision and Mission is depicted in the figure 2.

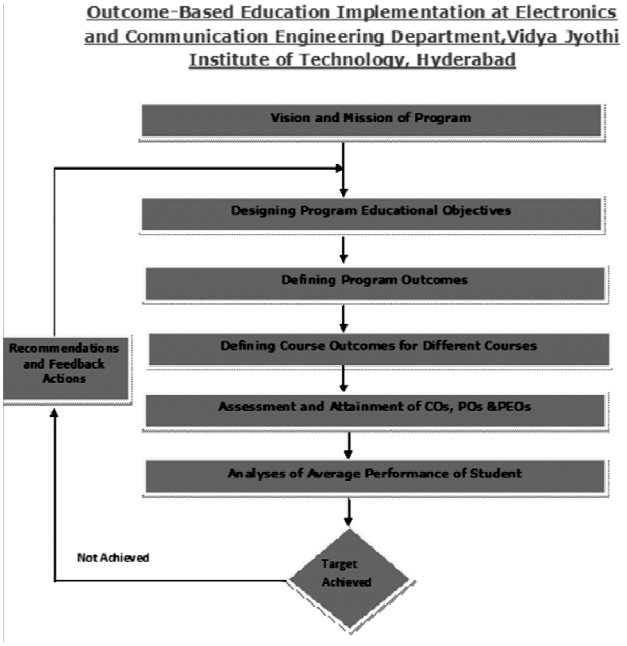

Fig. 1. Modeling of Outcome-Based Education at VJIT, Hyderabad

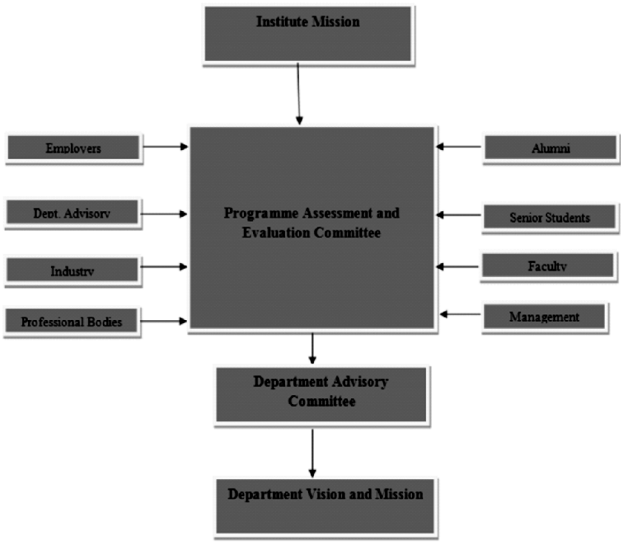

Fig. 2. Development process of ECE Department Vision and Mission.

After discussions of departmental vision and mission PEOs are defined in tune with the vision and mission of the institute. PEOs of ECE department are designed with the three important objectives/points technical competency is the first objective of our program. The main goal is to lay solid foundation and provide necessary skills to analyze, design, test hardware/software(s) as shown in the figure 3.

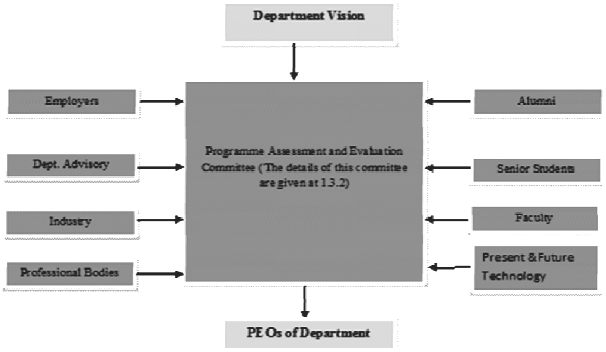

Fig. 3. Development process of ECE Department PEOs

4. Designing Inter-Disciplinary Teaching Methodology

Designing of Inter-disciplinary active learning and teaching methodology is certainly a challenging task for any two or more courses in any field of engineering education [7]. In the process of implementation of IDTM, Instructor should identify interdisciplinary courses related active learning topics for undergraduate level of engineering students to implement course/open-ended/academic/in-house/mini/major projects. These courses are taught using OBE approach and the following IDTLM is used to improve the teaching potential of engineering education in Electronics and Communication Engineering Education [8]. IDTLM is evaluated at the end of the semester by conducting quiz contests, seminars and demonstrations of their active learning knowledge and hands-on experience and their projects. This methodology is very useful for better attainment in OBE. The following are the main steps for implementing IDTLM for any two interdisciplinary courses in the engineering education as shown in the figure 4 with better understanding an engineering education [9]. We have taken-up two interdisciplinary courses named as Operating Systems and Embedded Systems to implement the IDTLM at Department of ECE, at Vidya Jyothi Institute of Technology, Hyderabad [10] [11].

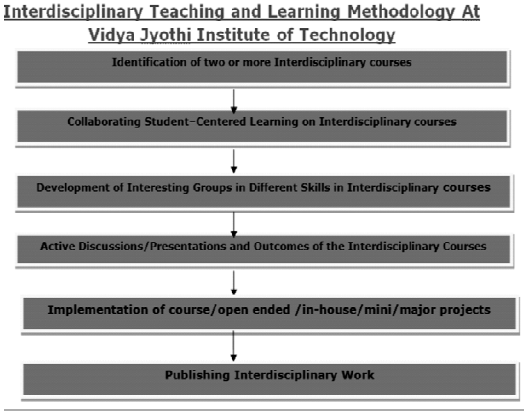

Fig. 4. Interdesciplinary Teaching and Learning Methodology

5. Results and Discussions

A. Interdisciplinary Teaching Learning Methodology for Operating System Course

This Methodology is suitable and huge field of reference for 3rd year and final year level courses to implement active learning methods to design course/open-ended/academic/mini/major [12]. We have incurred Operating Systems from Computer Science Engineering and Embedded Systems from Electronics and Commutation Engineering domain and successfully implemented IDTLM at Vidya Jyothi Institute of Technology, Hyderabad [13]. The course outlines an Operating System course, which specifies the course outcomes as shown in the figure.

Course Name	Operating System
Course Number	56024
Course Description	This course provides the basic knowledge about the Operating Systems concepts such as process, main memory management, secondary memory management, CPU and disk scheduling etc
Prerequisite(s)	None
Compulsory Text Books	1. Operating System Concepts- Abraham Silberchatz, Peter B. Galvin, Greg Gagne 7th Edition, John Wiley. 2. Operating systems- A Concept based Approach-D.M.Dhamdhere, 2nd Edition, TMH
Reference Text Books	1. Operating Systems – Internal and Design Principles Stallings, Sixth Edition– 2005, Pearson education 2. Modern Operating Systems, Andrew S Tanenbaum 3rd edition PH 3. Gary Nutt: Operating Systems, 3rd Edition, Pearson, 2014. 4. Operating System A Design Approach-Crowley, TMH
Course Organization	Four 50 min of lectures per week for 16 weeks
Course Evaluation	25 marks for Internal Evaluation 75 marks for the End-Examination Mini Project (Optional) Open-Ended-Experiment(Optional) Seminars(Optional) Quizzes(Optional)
Computer Usage	Windows and linux operating systems.
Course Outcomes	By the end of the course student will be able to do the following: 1. Ability to describe, contrast and compare differing structures for operating Systems 2. Ability to explore the basics of operating systems like kernel, shell, types and views of operating systems 3. Ability to analyze the theory and implementations of process management techniques 4. Ability to analyze the theory and implementations concepts including scheduling, synchronization ,deadlocks 5. Ability to Modify existing open source kernels in terms of functionality
Course Coordinated By	Prof. M.Rajendra Prasad & Prof.Ravi Mathey

Fig. 5 Course outline of Operating SystemCourse

A course project relating Operating Systems course to process creation and process ID display on linux operating system is depicted as shown in the figure 6.This is an example how theory is taught with practical approach [14].

```
# include <unistd.h>
# include <sys/types.h>
# include <stdio.h>

# define CHILD 0

main(){
       pid_t pid;
        printf(" My pid = %d \n", getpid());
        getchar();
        pid = fork();
        if( pid == CHILD){
                printf(" child: My pid = %d \n", getpid());
                while(1);
        }
        // parent
        else{
                printf(" My pid = %d \n", getpid());
                printf(" Newly created child pid = %d \n", pid);
        }
}
```

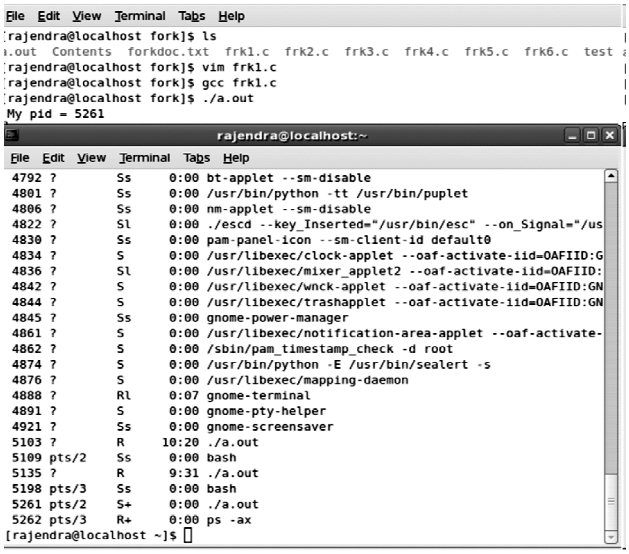

Fig. 6. Implementation of Process Management linux OS

An academic project entitled by Analysis of open source Linux Source Code is depicted in the figure 7.

Fig. 7. Analysis of Linux operating System Code

With this knowledge of Operating Systems our students are able to developaed test open source linux kernel for IPv6 support. The testing and evaluation commands of linux kernel are shown in the figure 8 and kernel with IPv6 supported is developed and is booted successfully is cited in the figure 9 with IPv6 address.

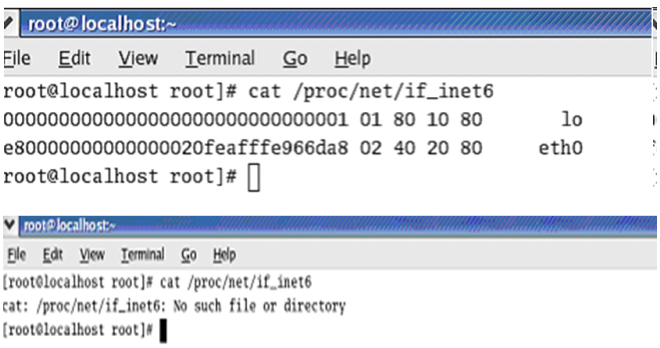

Fig. 8. IPv6 support testing on linux kernel

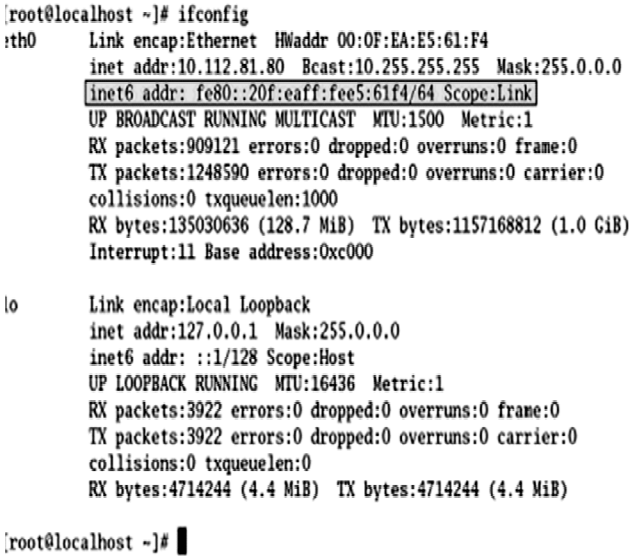

Fig. 9. IPv6 support of on linux operating system

A. Interdisciplinary Teaching Learning Methodology for Embedded System Course

The second course to implement IDTLM is Embedded Systems, which is studied at next Semester i.e at 4th year I-Semester [15]. This course consists of sequence of lessons that emphasizes on the embedded system design concepts and the course outline of Embedded System is described in the figure 10. In this course, Instructor explains the usage and linkage between the concepts and features of operating systems and customized hardware. Instructor also explains the procedure to develop the embedded system for a specific application using any processor board [16]. In our class, the Instructor discussed architecture of the X86, ARM 7, ARM 9 and ARM 11 processor board and features of operating system running on these processor boards. Instructor also expressed many active learning methods like demonstrating linux operating system code from open source website kernel.org. As a result these discussions and clarifications with different issues, students are able to transplant latest kernel from kernel.org as their major project and they are able to analysis the ARM9 and ARM 11 and X86 processor board for telecom application as shown in the figure 11. A cross compiler environment of PowerPC, ARM is created and executable difference is analyzed as shown in the figure 12.

Course Name	EMBEDDED SYSTEMS
Course Number	57043
Course Description	This course provides to understand and design embedded systems by learning basics of operating systems and RTOS. The course introduces interfacing the memory concepts and explores the firmware design approaches.
Prerequisite(s)	Micro Processors and Micro Controllers
Compulsory Text Books	1. Computers as Components-principles of Embedded computer system design, Wayne Wolf, Elsevier. 2. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.
Reference Text Books	1.Embedding system building blocks, Labrosse, via CMP publishers. 2. Embedded Systems, Raj Kamal, TMH. 3. Micro Controllers, Ajay V Deshmukhi, TMH. 4. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley. 5. Microcontrollers, Raj kamal, Pearson Education. 6. An Embedded Software Primer, David E. Simon, Pearson Education.
Course Organization	Four 50 min of lectures per week for 16 weeks3 hours of Lab per week for 16 weeks
Course Evaluation	25 marks for Internal Evaluation 75 marks for the End-Examination Course/Mini Project (Optional) Open-Ended-Experiment(Optional) Seminars(Optional) Quizzes(Optional)
Computer Usage	Keil/Linux RTOS/ARM Processor Board Specifications
Course Learning Outcomes	By the end of the course student will be able to do the following: 1. Ability to design an embedded application on host system. 2. Ability to test 8051 based embedded system. 3. Ability to design and develop ARM based embedded system. 4. Ability to apply the knowledge of operating systems for embedded systems. 5. Transplant linux RTOS to X86/ARM Processor boards.
Course Coordinated By	Prof. M.Rajendra Prasad

Fig. 10. Course outline of Embedded Systems Course

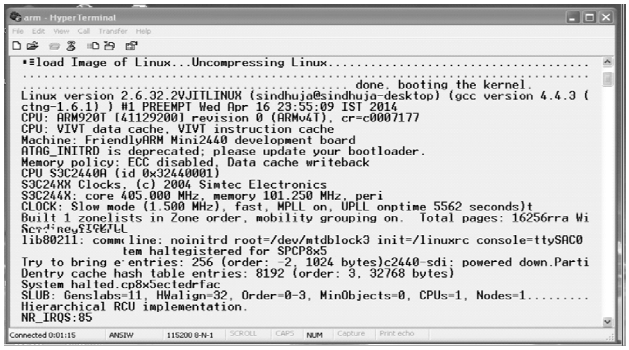

Fig. 11. Propritory linux operating system (VJITLINUX) is transplanted on to ARM920T Processor Board

```
root@localhost D1]# ls
1.c  myarm  myintel  myppc
root@localhost D1]# file D1.c
1.c: ASCII text
root@localhost D1]# file myintel
yintel: ELF 32-bit LSB executable, Intel 80386, version 1 (SYSV), for GNU/Linux 2.6.9, dynamically linked (uses shared libs),
ed
root@localhost D1]# file myppc
yppc: ELF 32-bit MSB executable, PowerPC or cisco 4500, version 1 (SYSV), for GNU/Linux 2.4.3, dynamically linked (uses share
t stripped
root@localhost D1]# file myarm
yarm: ELF 32-bit LSB executable, ARM, version 1 (ARM), for GNU/Linux 2.0.0, dynamically linked (uses shared libs), for GNU/Li
root@localhost D1]#
```

Fig. 12. Analysis of Cross Compiler Executables

This IDTLM is compared with the Conventional Methodology (CM), where CM is a defined as the pedagogy where the faculty leads and controls the class, orally exhibits the course lessons while students listen and take note passively. There is no active interaction with the faculty and the students. The difference between CM and IDTLM is compared for MID1 & MID2 examination marks and calculated CO attainment and graphically represented as shown in the figure 13.From the analysis, IDTLM got very good attainment than CM [17].CO-PO mapping is depicted in the figure 14.

Vidya Jyothi Institute of Technology
Department of Electronics and Communication Engineering
Course Outcome Assessment Methodology-Embedded Systems

Conventional Methodology

CO's	MID -I										MID -II										Total Attainment Level of CO	Average Level of COs attainment on a 5 point scale
	1A	1R	2A	2R	3A	3R	4A	4R	5A	5R	1A	1R	2A	2R	3A	3R	4A	4R	5A	5R		
CO1	60	40									60	57									80.83333	4.041666667
CO2			60	40									60	58							81.66667	4.083333333
CO3					60	40									60	56					80	4
CO4							60	40									60	55			79.16667	3.958333333
CO5									60	40									60	55	82.6087	4.130434783

InterDisciplinary Teaching and Learning Methodology

CO's	MID -I										MID -II										Total Attainment Level of CO	Average Level of COs attainment on a 5 point scale
	1A	1R	2A	2R	3A	3R	4A	4R	5A	5R	1A	1R	2A	2R	3A	3R	4A	4R	5A	5R		
CO1	60	55									60	57									93.33333	4.666666667
CO2			60	55									60	58							94.16667	4.708333333
CO3					60	56									60	56					93.33333	4.666666667
CO4							60	53									60	55			90	4.5
CO5									60	50									60	55	91.30435	4.565217391

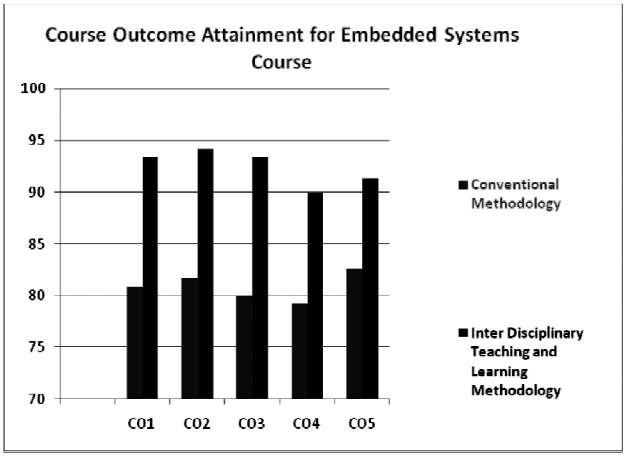

Fig. 13. CO analysis for IDTLM and CM

	Program Outcomes	Course Outcomes				
		CO1	CO2	CO3	CO4	CO5
PO1	An ability to apply knowledge of mathematics, science, and engineering	√				
PO2	An ability to design and conduct experiments, as well as to analyze and interpret data				√	
PO3	An ability to design a engineering system, component, or process to meet desired needs			√		
PO4	An ability to function on an inter-disciplinary team					
PO5	An ability to identify, formulate, and solve engineering problems					
PO6	An understanding of professional and ethical responsibility					
PO7	An ability to communicate effectively					
PO8	The broad education necessary to understand the impact of engineering solutions in a global societal context					
PO9	An ability to engage in life-long learning					
PO10	Knowledge of contemporary issues					
PO11	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice					
PO12	An ability to demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work as a member and leader in a team, to manage projects					

Fig. 14. CO-PO Mapping

The attainment of CO-PO for embedded system course is calculated and analysed with the attainment value with the IDTLM,and it proved with the best results as shown in the figure 15 .

Vidya Jyothi Institute of Technology
Department of Electronics and Communication Engineering
Course Outcome - Program Outcome Assessment - Embedded System Course

			Conventional Methodology										InterDisciplinary Teaching and Learning Methodology									
CO's	Mid Term Examination Evaluation		PO1		PO2			PO3		PO12		CO's	Mid Term Examination Evaluation	PO1		PO2			PO3		PO12	
			1A	1R	2A	2R	4A	4R	3A	3R	5A	5R			1A	1R	2A	2R	4A	4R	3A	3R	5A	5R
CO1	MID - 1		60	49									CO1	MID - 1	60	57								
	MID - 2		60	48										MID - 2	60	59								
CO2	MID - 1				60	53							CO2	MID - 1			60	55						
	MID - 2				60	52								MID - 2			60	52						
CO3	MID - 1								60	52			CO3	MID - 1							60	52		
	MID - 2								60	49				MID - 2							60	57		
CO4	MID - 1						60	44					CO4	MID - 1					60	55				
	MID - 2						60	48						MID - 2					60	58				
CO5	OEP										30	25	CO5	MID - 1									30	28
Total PO Attainment		80.8333333			82.08333333				84.1667		83.33333		Total PO Attainment		96.66667		91.66666667				90.83333		93.33333	

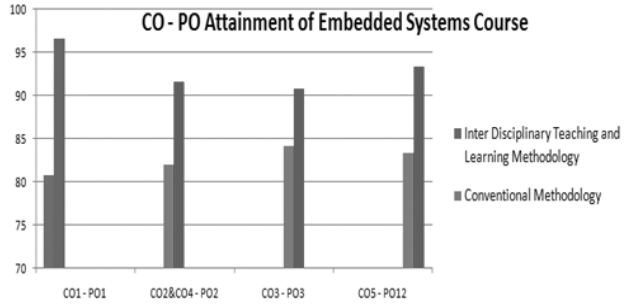

Fig. 15. CO-PO attainment

The following table compares and analysed with the different parameters such as average MID marks, number of course/open-ended/academic/in-house/mini/major projects and graphically represented for better attainment values as shown in the figure 16. A major project ARM based embedded quad copter is designed and the testing process is depicted in figure 17.

Parameter	Conventional Methodology	InterDisciplinary Teaching and Learning Methodology
Average Mid Term Marks	13.23	16.1
Course Projects	4	8
Academic Projects	8	12
Open Ended Projects	3	6
Mini Projects	4	6
Major Projects	2	4
Paper Publications	1	5

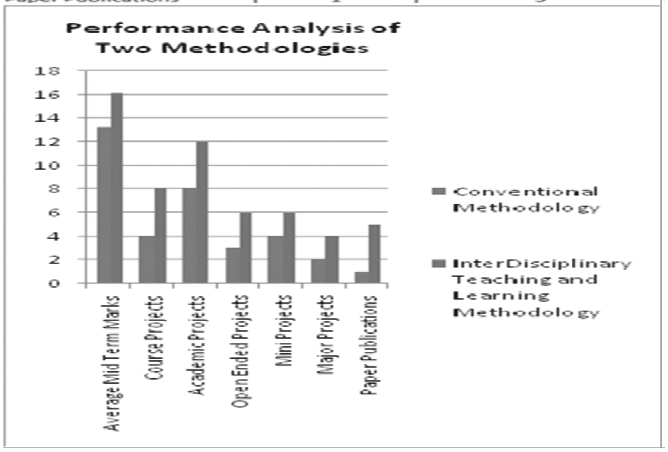

Fig. 16. Performance Anlaysis of CM&IDTLM

Fig. 17. Testing of ARM based embedded quadcopter

6. Conclusion

This paper describes an innovative Interdisciplinary Teaching and Learning Methodology and successfully implemented for different courses. The framework of Outcome Based Approach is developed at the Department of Electronics and Communication Engineering, Vidya Jyothi Institute of Technology, Hyderabad, India to teach various courses and compared differences between CM & IDTLM and implemented successfully for Operating System and Embedded Systems for Electronics Engineering Education. The performance analyses of students with the two methodologies are compared and better methodology is recommended for OBE implementation. This

approach gives students to learn concepts and course contents actively. After this course with the IDTLM concepts students are able to not only design a course/open-ended/academic/in-house/mini/major project also able to present their projects as a technical paper at International/National Conferences or well reputed research journals globally. The IDTLM also helps for better attainment of CO & CO-PO.

Acknowledgement

We would like to thank all faculty members for their continues support for implementation of OBE at Vidya Jyothi Institute of Technology, Hyderabad. We would like to thank Correspondent, Director and Principal of Vidya Jyothi Institute of Technology, Hyderabad for their encouragement to implement OBE framework.

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