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HBL for Effective Implementation of Problem Statements during Lab Session

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Abstract: Practical work motivates the students, inspires their interest in the course, enhances their understanding about the course, improves the problem analysing and solving skills, bridge the gap between teachings and understanding the course, concentrate on the fundamentals and its application etc. Various active and cooperative learning methods are practiced in the teaching-learning process to engage students in activity-based or problem-based learning and motivate them to enhance their understanding about the course. In this study, we considered the handout based learning during the laboratory session and titled this activity as HBL (Handout based Learning).
We have designed the handouts for the various courses like C-Programming, Digital Technique, System Programming and Mobile Application Development course of Computer and Allied branches.
Also we considered the case study of HBL for Mobile Application Development and Digital Technique course. Based on the students' response and feedback for HBL activity, we observed that there is an improvement in the students' problem solving skill and application implementation.

Keywords: Handout, Learning Objective, Likerts' Scale, Handout based Learning (HBL)

1. Introduction

Lab-based learning encourages active learning, effective decision making, improve critical thinking, and when working in small groups can further develop students' cooperative skills. There are a number of ways to enhance the laboratory environment. It is possible by integrating theory with practice and blending other active learning strategies such Think-Pair-Share, Team-Pair-Solo, Flipped classroom etc. with lab based learning to provide enhanced higher level reasoning skills.

If it required exploring the effectiveness of lab assignments for achieving its goal, we should be clear about the aim of each assignment, learning objective of the assignment, what to do in that assignment, what

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is the procedure to accomplish the task, and what is the result etc.

In laboratory, instructor generally tell students to "do this," "record this," "tell me what you observed," and, in some cases, "interpret what you observed," or they ask, "what are the implications of what you observed?" Although students following these "cookbook" protocols are "active," they are not necessarily involved in active learning because they may not explicitly be testing their mental models against the phenomena that they are observing (Modell HI, 1991)

2. Related Work

There are many ways to conduct the laboratory session. There are many benefits from engaging students in laboratory activities (Dkeidek et al. 2012; Hofstein 2004; Hofstein et al. 2008; Woolnough 1991)

If the prediction and wrap-up periods were regular features of the lab sessions, the degree of success achieved by this approach might improve as the students gain more practice with the process. (Harold I. Modell, Joel A. Michael, Tom Adamson, Barbara Horwitz, 2003)

The study indicate that laboratory instruction is more effective when students verbalize predictions from their mental models than when they only "discover" the outcome of the experiment.(Modell HI, Michael JA, Adamson T, Goldberg J, Horwitz BA, Bruce DS, Hudson ML, Whitescarver SA, and Williams S., 2000)

The study carried out by Ingebjørg Strand et.al. (2009) has examined students' responses to how they learn in a skills laboratory.

Toplis (2012) found that laboratory or practical work provides opportunities for students to engage with, influence their own learning, provide opportunity to participate etc.

Clara Davies (2008) considered the practical challenges of designing laboratory learning within engineering curriculum.

Ahmed Ishtiak et al.(2013) used experimental teaching technique to teach Mobile Application Development. In their experiment it is shown that the experimental approach is effective as compared to the traditional in teaching mobile application development.

In this study, we consider the handout based learning during the laboratory session.

3. Handout

A handout is a paper based resources provided to the students during laboratory session. It increase attention and motivation and help students to follow the development of an idea or argument. (http://users.wmin.ac.uk/mcshand/TEACHING/handouts.htm). So it is guided document used by learners which is useful for implementing the problem statements in the lab session.

Following list the purpose of handout in teaching-learning process -

i) To allow teacher to limit the extent of course content cover in their presentation and no spill over of the information.
ii) To allow teacher to include all points to be taught.
iii) To remind/recall to the students with respect to teacher presentation or assignments.
iv) Queries raised by students can be easily noted with the help of handout and can be asked to teacher later.
v) Allow students to concentrate on fundamentals and its applications rather than simply taking down notes for assignment implementation during classroom session.
vi) To provide appropriate answer to student's/learner's questions like how, why and when.

4. HBL(Handout based Learning)

In this study, we consider handouts based learning during laboratory session and titled this activity as Handout based Learning (HBL). Handout based Learning (HBL) is an activity in which handouts for practical assignments of the course will be given to the students for assignment completion during the laboratory session.

We designed the handouts for the courses given in the following Table 1.

We conducted the HBL activity for the course 'Mobile

Application Development' and 'Digital Technique' and presented the result and feedback of using this activity in laboratory session.

The sample C-Programming handout for one of the assignment is shown in the Figure 1.

Table 1: HBL for the courses

Sr. #	Name of course	Year	Type of Course	Brach	No. of Handouts
1	C-Programming	First Year Engineering	Software	Any Stream	10
2	Digital Technique	Second Year Engineering	Hardware	1)Computer Science and Allied Branches 2) Electronics and Allied Branches	12
3	System Programming	Third Year Engineering	Software	Computer Science and Allied Branches	12
4	Mobile Application Development	Final Year Engineering	Software	Computer Science and Allied Braches	10

A. Handout for C-Programming

C-Programming course is of paramount importance as this language is the base for all programming language like C++, Java, etc.

Each handout for C-Programming contains

- Program Statement,
- Learning Objectives,
- Theory, Algorithm
- Flowchart,
- Program,
- Input,
- Output,
- Practise Problem Statement,
- Conclusion and
- Learning Outcome

The handouts for C-Programming are available on the following webpage links.

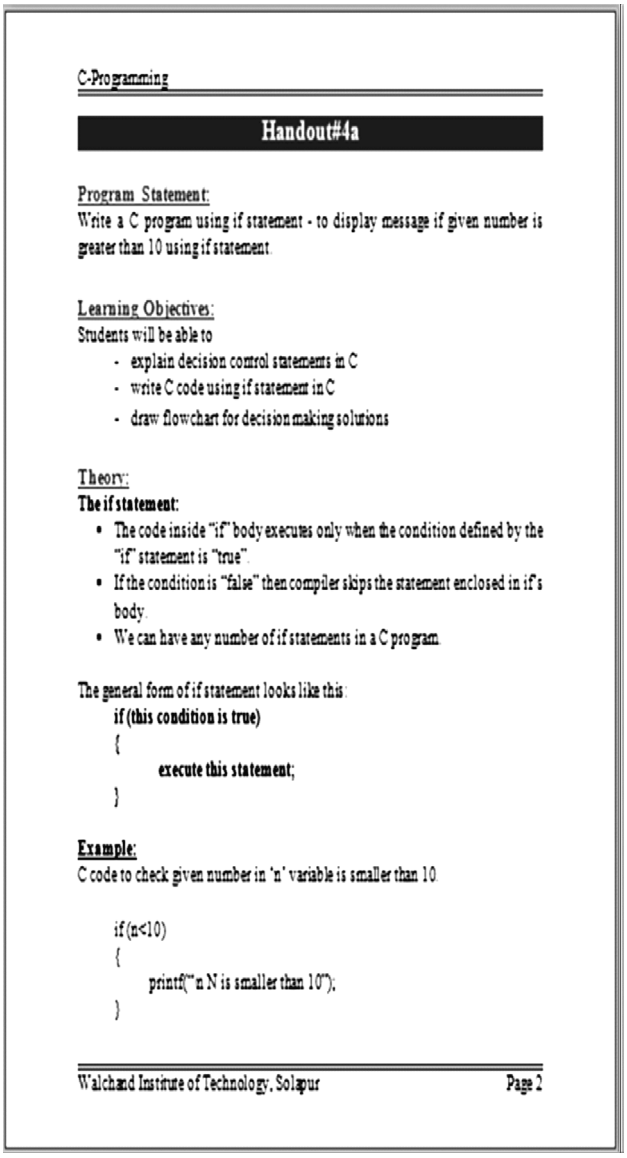
https://truptiindi.wordpress.com/courses/c-programming/lab-handout/

or

https://sunitadolwit.wordpress.com/study-material/c-programming-2/lab-handouts/

These handouts are also available on slideshare.net and the links is http://www.slideshare.net/trupti1976/ or

http://www.slideshare.net/SunitaAher1/



C-Programming

Handout#4a

Program Statement:
Write a C program using if statement - to display message if given number is greater than 10 using if statement.

Learning Objectives:
Students will be able to
- explain decision control statements in C
- write C code using if statement in C
- draw flowchart for decision making solutions

Theory:
The if statement:
- The code inside "if" body executes only when the condition defined by the "if" statement is "true".
- If the condition is "false" then compiler skips the statement enclosed in if's body.
- We can have any number of if statements in a C program.

The general form of if statement looks like this:

```
if (this condition is true)
{
    execute this statement;
}
```

Example:
C code to check given number in 'n' variable is smaller than 10

```
if (n<10)
{
    printf("\n N is smaller than 10");
}
```

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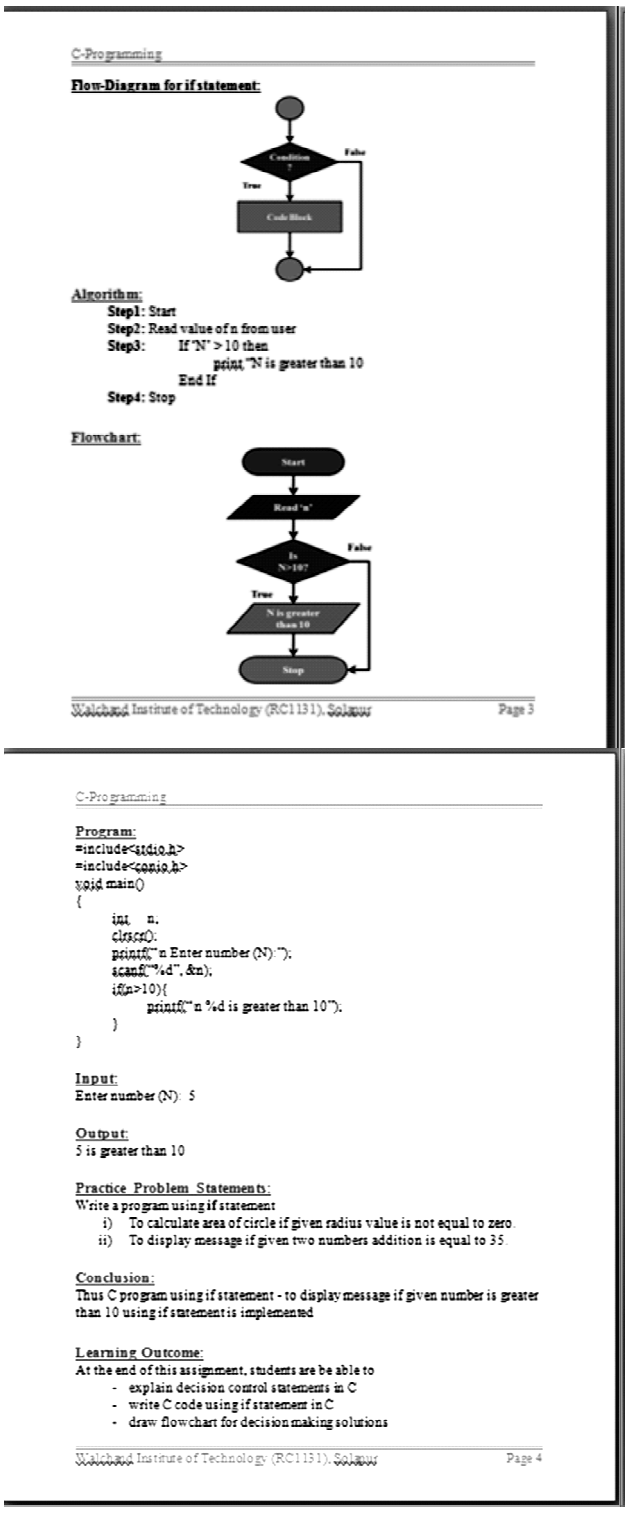

C-Programming

Flow-Diagram for if statement:

Algorithm:

Step1: Start
Step2: Read value of n from user
Step3: If 'N' > 10 then
print "N is greater than 10
End If
Step4: Stop

Flowchart:

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C-Programming

Program:

```
#include<stdio.h>
#include<conio.h>
void main()
{
      int   n.
      clrscr();
      printf("\n Enter number (N):");
      scanf("%d", &n);
      if(n>10){
            printf("\n %d is greater than 10");
      }
}
```

Input:
Enter number (N): 5

Output:
5 is greater than 10

Practice Problem Statements:
Write a program using if statement
i) To calculate area of circle if given radius value is not equal to zero.
ii) To display message if given two numbers addition is equal to 35.

Conclusion:
Thus C program using if statement - to display message if given number is greater than 10 using if statement is implemented

Learning Outcome:
At the end of this assignment, students are be able to
- explain decision control statements in C
- write C code using if statement in C
- draw flowchart for decision making solutions

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Fig.1. Sample C-Programming Handout

B. Handout for Digital Technique

Digital Technique is the course of Second Year Computer & Allied branches and Electronics & Allied branches. This course is also important from competitive examination point of view like GATE (General Aptitude Test for Engineering). Hence the handout for this was designed and used during the laboratory session. Each handout of this course contains

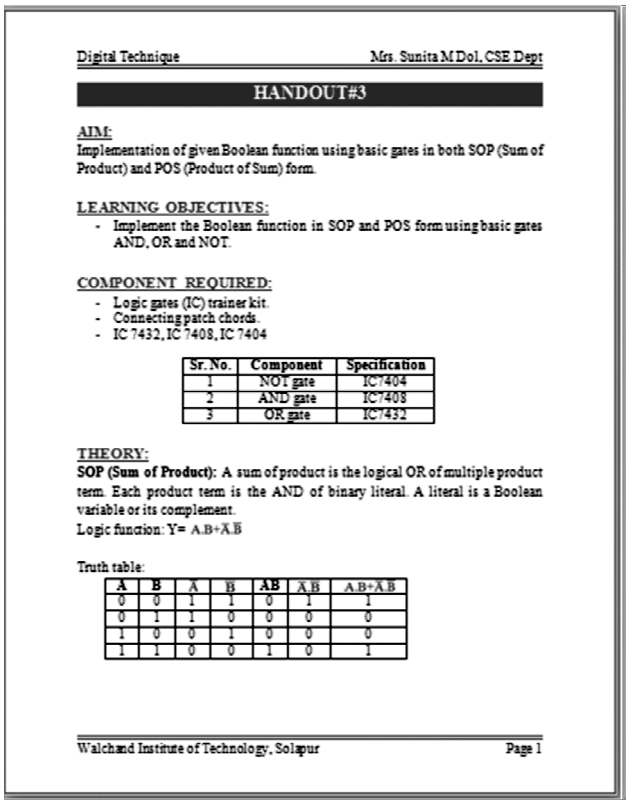
- Aim of an experiment,
- Learning Objectives,
- Component required to perform the experiment,
- Theory,
- Procedure and
- Result.

The handouts for this course is available on following faculty webpage

https://sunitadolwit.wordpress.com/study-material/digital-technique-2/lab-handouts/

or these handouts are available on slideshare.net http://www.slideshare.net/SunitaAher1/.

The sample handout for the problem statement 'Implementation of given Boolean functions using basic gates in both SOP (Sum of Product) and POS (Product of Sum) form' designed for this course is given in the Figure 2.



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HANDOUT#3

AIM:
Implementation of given Boolean function using basic gates in both SOP (Sum of Product) and POS (Product of Sum) form.

LEARNING OBJECTIVES:
- Implement the Boolean function in SOP and POS form using basic gates AND, OR and NOT.

COMPONENT REQUIRED:
- Logic gates (IC) trainer kit.
- Connecting patch chords.
- IC 7432, IC 7408, IC 7404

Sr. No.	Component	Specification
1	NOT gate	IC7404
2	AND gate	IC7408
3	OR gate	IC7432

THEORY:
SOP (Sum of Product): A sum of product is the logical OR of multiple product term. Each product term is the AND of binary literal. A literal is a Boolean variable or its complement.
Logic function: $Y = A.B + \bar{A}.\bar{B}$

Truth table:

A	B	$\bar{A}$	$\bar{B}$	AB	$\bar{A}\bar{B}$	$A.B+\bar{A}.\bar{B}$
0	0	1	1	0	1	1
0	1	1	0	0	0	0
1	0	0	1	0	0	0
1	1	0	0	1	0	1

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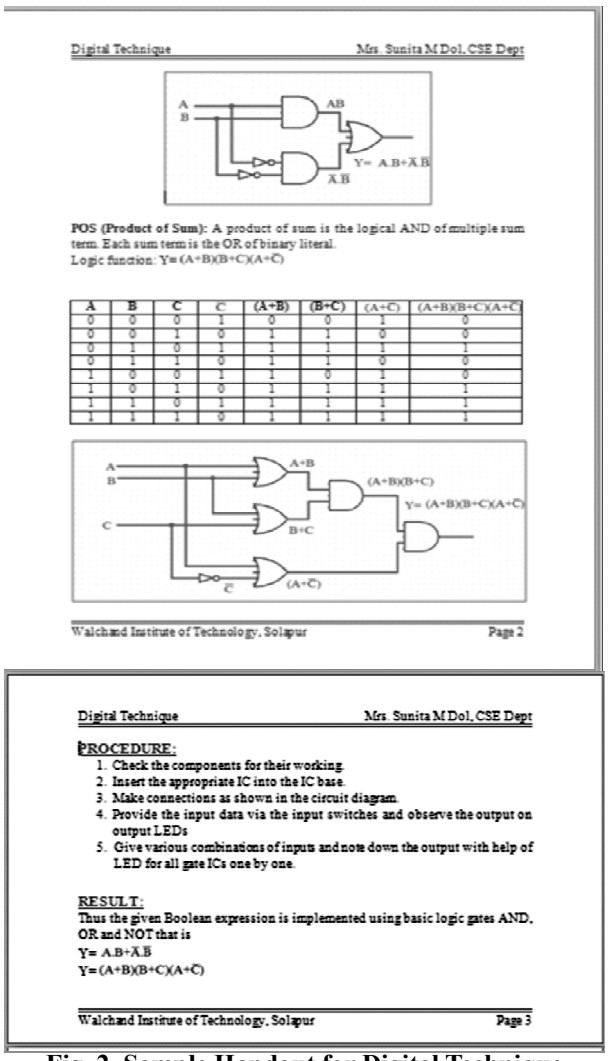

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POS (Product of Sum): A product of sum is the logical AND of multiple sum term. Each sum term is the OR of binary literal.
Logic function: Y= (A+B)(B+C)(A+C)

A	B	C	C	(A+B)	(B+C)	(A+C)	(A+B)(B+C)(A+C)
0	0	0	1	0	0	1	0
0	0	1	0	0	1	0	0
0	1	0	1	1	1	1	1
0	1	1	0	1	1	0	0
1	0	0	1	1	0	1	0
1	0	1	0	1	1	1	1
1	1	0	1	1	1	1	1
1	1	1	0	1	1	1	1

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PROCEDURE:

1. Check the components for their working.
2. Insert the appropriate IC into the IC base.
3. Make connections as shown in the circuit diagram.
4. Provide the input data via the input switches and observe the output on output LEDs
5. Give various combinations of inputs and note down the output with help of LED for all gate ICs one by one.

RESULT:

Thus the given Boolean expression is implemented using basic logic gates AND, OR and NOT that is

Y= A.B+A.B

Y= (A+B)(B+C)(A+C)

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Fig. 2. Sample Handout for Digital Technique

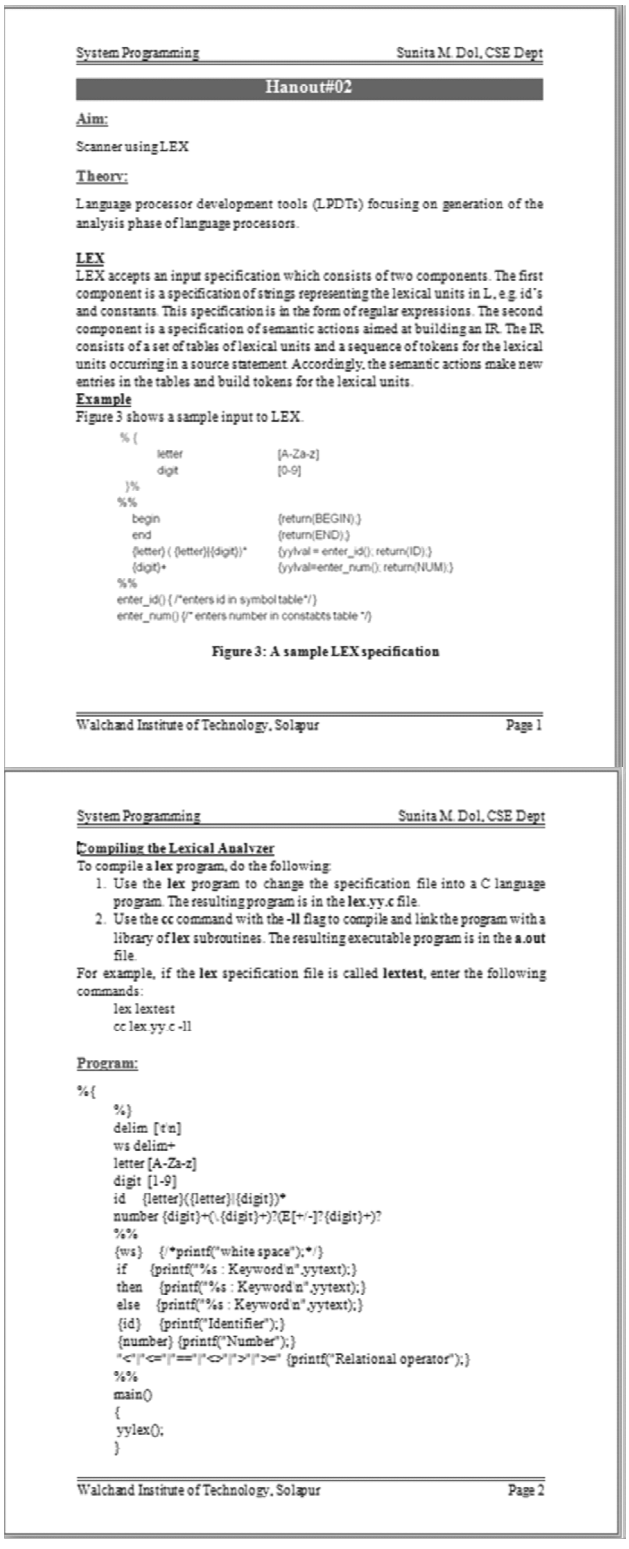
C. Handout for System Programming

System Programming of Third Year is the core course of Computer Science & Engineering Under Graduate (UG) programme and is the prerequisite for the course Compiler Construction. This course consists of algorithms which are required to be implemented during the laboratory sessions. So students generally find the lab assignments of this course difficult to implement. Hence the handouts for this course were designed so that students can use these handouts as guidelines during the laboratory session.

Each handout of this course consists of

- Aim,
- Theory,
- Program or Algorithm depending on the problem statement, Input,
- Output and
- Conclusion.

The sample handout of System Programming for the problem statement 'Scanner using LEX' is given in the Figure 3.



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Hanout#02

Aim:

Scanner using LEX

Theory:

Language processor development tools (LPDTs) focusing on generation of the analysis phase of language processors.

LEX

LEX accepts an input specification which consists of two components. The first component is a specification of strings representing the lexical units in L, e.g. id's and constants. This specification is in the form of regular expressions. The second component is a specification of semantic actions aimed at building an IR. The IR consists of a set of tables of lexical units and a sequence of tokens for the lexical units occurring in a source statement. Accordingly, the semantic actions make new entries in the tables and build tokens for the lexical units.

Example

Figure 3 shows a sample input to LEX.

```
% {
        letter              [A-Za-z]
        digit               [0-9]
 }%
%%
   begin                    {return(BEGIN);}
   end                      {return(END);}
   {letter}({letter}|{digit})*   {yylval = enter_id(); return(ID);}
   {digit}+                 {yylval=enter_num(); return(NUM);}
%%
enter_id() { /*enters id in symbol table*/}
enter_num() {/* enters number in constabts table */}
```

Figure 3: A sample LEX specification

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Compiling the Lexical Analyzer

To compile a **lex** program, do the following:

1. Use the **lex** program to change the specification file into a C language program. The resulting program is in the **lex.yy.c** file.
2. Use the **cc** command with the **-ll** flag to compile and link the program with a library of **lex** subroutines. The resulting executable program is in the **a.out** file.

For example, if the **lex** specification file is called **lextest**, enter the following commands:

```
lex lextest
cc lex.yy.c -ll
```

Program:

```
%{
    %}
    delim [ \t\n]
    ws delim+
    letter [A-Za-z]
    digit [1-9]
    id   {letter}({letter}|{digit})*
    number {digit}+(\.{digit}+)?(E[+/-]?{digit}+)?
    %%
    {ws}    {/*printf("white space");*/}
    if      {printf("%s : Keyword\n",yytext);}
    then    {printf("%s : Keyword\n",yytext);}
    else    {printf("%s : Keyword\n",yytext);}
    {id}    {printf("Identifier");}
    {number} {printf("Number");}
    "<"|"<="|"=="|"<>"|">"|">=" {printf("Relational operator");}
    %%
    main()
    {
    yylex();
    }
```

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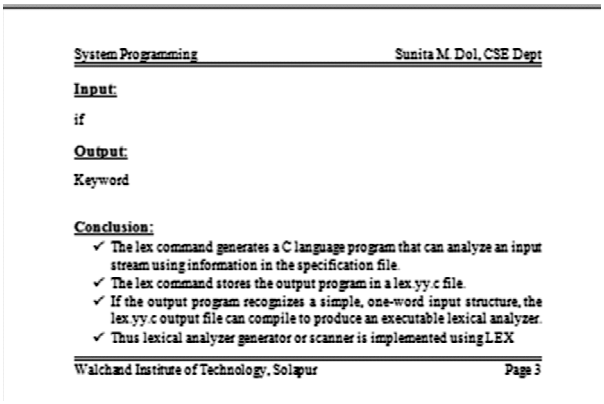
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Input:

if

Output:

Keyword

Conclusion:

- ✓ The lex command generates a C language program that can analyze an input stream using information in the specification file.
- ✓ The lex command stores the output program in a lex.yy.c file.
- ✓ If the output program recognizes a simple, one-word input structure, the lex.yy.c output file can compile to produce an executable lexical analyzer.
- ✓ Thus lexical analyzer generator or scanner is implemented using LEX

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Fig.3. System Programming Handout Sample

These handouts are available on the webpage link https://sunitadolwit.wordpress.com/study-material/system-programming/lab-handouts/. These handouts are available on slideshare.net and link is http://www.slideshare.net/SunitaAher1/

D. Handout for Mobile Application Development

The need of designing and implementing the applications for mobile device is ever increasing in market. In accordance with the projections regarding the requirements of the society and IT industry, Mobile Application Development course is introduced in engineering curriculum. 'Mobile Application Development (MAD)' is the new course introduced for Computer and Allied branches and now it is the most popular course amongst the students and the course has employability enhancing potential. Since it is an emerging technology based course, it is necessary to emphasise the need of clear understanding of the fundamentals of this course.

This course is of paramount importance from the design & development of various mobile applications for android platform based devices.

Handout designed and used in this experiment for teaching "Mobile Application Development" course, contains:

(I) Practical Assignments

(II) Theoretical/Instructional Assignments

Practical Assignments consists of assignment Statement, Design guidelines, Screenshot of expected app, Functionality (Steps) and other approaches for implementation (optional).

Theoretical or Instructional Assignments consists of topic based questions, synopsis of mini-project and mini-project presentation and completion.

Hence the handout for this course was designed and available on t he following link.

https://truptiindi.wordpress.com/courses/mobile-application-development/lab-handouts/

or on the slideshare.net and link is http://www.slideshare.net/trupti1976/

The sample handout of Mobile Application Development for the problem statement 'Design and implement Login App form using Android UI (User Interface) elements' is given in the Figure 4.

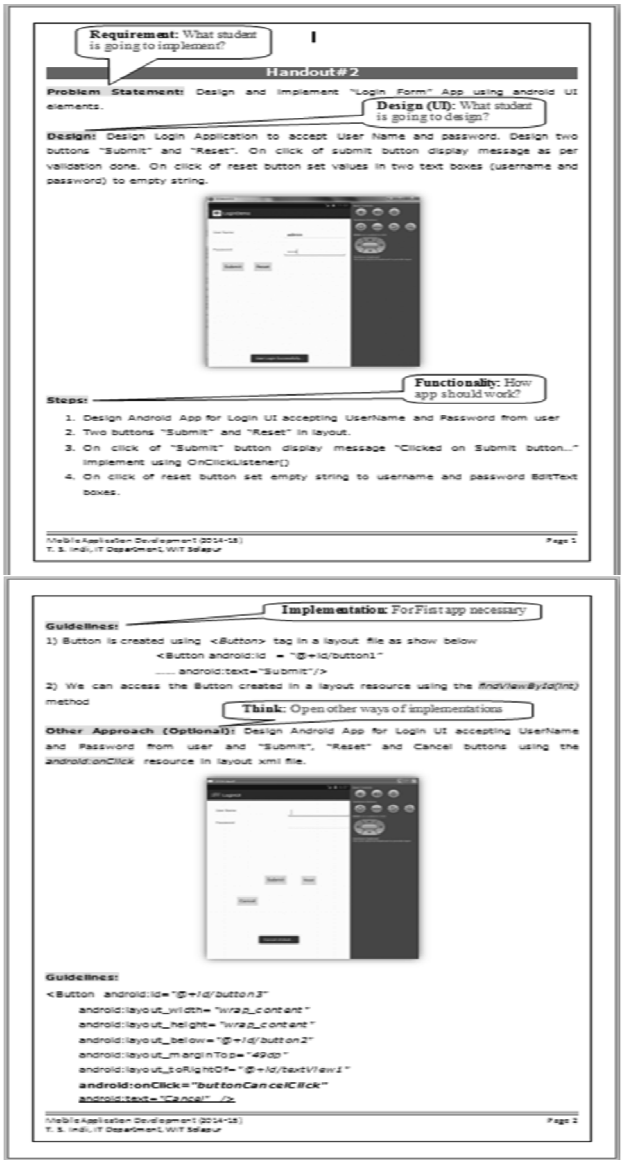

Fig. 4: Sample Handout of the course Mobile Application Development

5. HBL for Mobile Application Development Course:

To check the effect of HBL on students, two group pre-post test experimental studies was carried out with the learning objective (LO)- design and implement mobile applications using modern mobile development tools for android. A group of 60 students is used for this experiment. Out of 60 students, 30 students' group is used as control group and 30 students' group is used as experiment group. While forming experimental and control groups, it is ensured that both groups are validated based on pre-requisite test conducted on java programming language.

As listed in experiment setup, first the teacher taught the content from this course in classroom by experimental teaching method i.e. using power point presentation & demonstration example to explain that concept then students implement same in classroom and assignment based on same topic discussed in class. Till this, procedure is same for both group members. The difference is the point where assignment implementation starts. For control group handout is not provided and for experimental group handout is provided as shown in Figure 5.

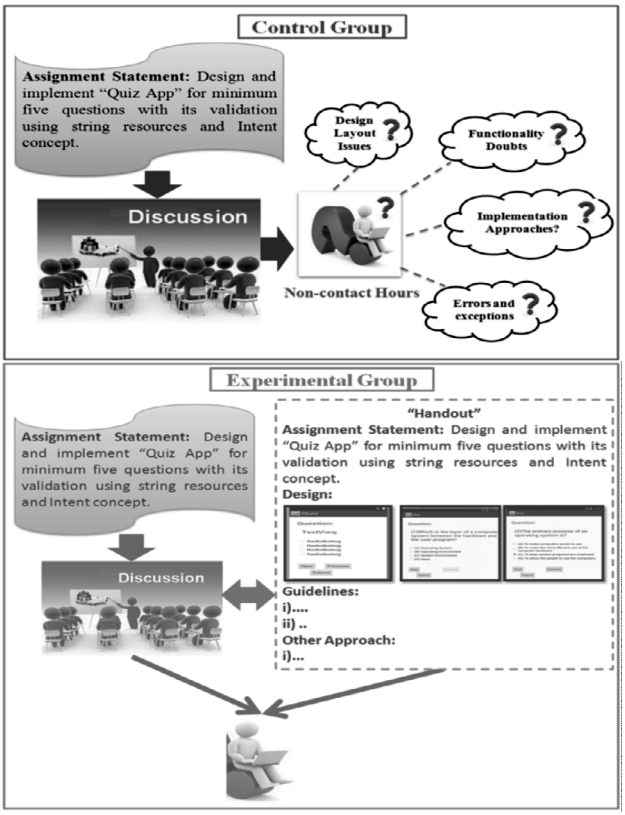

Fig. 5: Experimental Setup

The students' performance was measured in terms of number of assignments completed by each student in every group and through contribution and completion of mini-project as shown in Table 1. It is observed that the "Theoretical/Instructional Assignments" were completed by more than 85% students in both groups where as the completion percentage of experimental group was more than the control group for "Practical Assignments". The students who completed the assignments based on each topic could apply the knowledge of those topics during project implementation. Therefore, it is necessary to make sure that the students complete assignments or tasks designed by the teacher. We used factors like task completion, mini-project involvement and a few MCQ tests on the same topic to measure effectiveness of use of handouts during this experiment.

Students in experimental group performed significantly better than control group as shown in Table 2 and Figure 6.

Table 2: Student's Assignment Submission in Control and Experimental

Sr. #	Assignment Statements	Control Group	Experimental Group
1	Introduction to Mobile Application Development.	92%	96%
2	Design and implement "Login Form" App using android UI elements.	53%	92%
3	Design and implement "Quiz App" for minimum five questions with its validation using string resources and Intent concept.	55%	89%
4	Asynchronous Task (Written Assignment).	89%	94%
5	Design and implement Calculator (Arithmetic Operations) App using AsyncTask concept.	55%	89%
6	Design and implement an application using Bound Service.	68%	91%
7	Design and implement an application using Notification concept.	69%	93%
8	Synopsis of Mini Project.	52%	89%
9	Design and implement an application to read and write Flat File to (i) internal memory of mobile device and (ii) external memory (SD card) of the device.	65%	85%
10 (A) (B)	Design and implement an application using "Shared Preferences" concept to change theme of your application. Design and implement an application using SQLite to insert, delete, update and display Faculty information into database.	68%	92%
11	Mini-Project	65%	85%

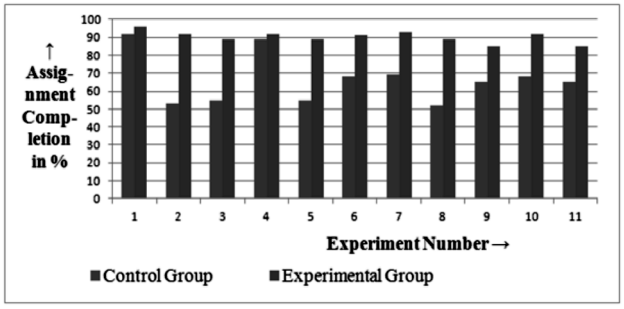

Fig. 6: Student's Assignment Submission Graph

We used a survey instrument with Likert-scale to collect students' feedback to know the students' perception about the way course was taught and about the handout and its use, as shown in Table 3. It shows the students' feedback for MAD course delivery with experimental setup and handout based teaching-learning method. Table 3 shows that 86% students agreed that the use of handouts enriched their knowledge and helped in the implementation of Mobile Application Development programs.

Table 3: Student's Feedback on Teaching of MAD Course with Concept Demonstration and Use of Handouts

Sr. No.	Questions	Agree	Neutral	Disagree
1	Due to immediate implementation in classroom session after concept explanation, you are able to implement program completely in the same session.	80%	18%	2%
2	You are able to map concept explained in classroom session and program statements (assignments) given for practice session.	92%	5%	3%
3	Handout provided for this course was helpful to accomplish task.	98%	2%	0%
4	Guidelines provided in handouts guided you to complete task.	96%	3%	1%
5	Design provided in this handouts was helpful to designing an app	99%	0%	1%
6	Handout was supportive document to encourage for accomplishment of assignments	87%	11%	2%
7	Other approach to implement app was helped to think implementation of same app in different ways.	91%	5%	4%
8	Mini-project instructions in handout helpful	82%	12%	6%
9	Overall handout enriched our interest in implementation of Mobile Application Development Assignments	86%	6%	8%

6. HBL for Digital Technique Course:

Handout for this course was given to the students at the start of laboratory session. Students will do the following things

- Read the problem statement
- Try to solve this problem statement
- Go through the handout
- Go through the learning objective of this experiment
- Study the theory part
- Solve logical expression if any
- Draw the circuit diagram and check the same with the diagram given in the handout
- Make the connections as per the instruction in the handout provided
- Perform an experiment according to the instruction given in the handout
- Check the result of experiment with the result given in the handouts
- Contact instructor related to any query

To know students' perception about this handout based learning, the feedback was conducted using a survey instrument Likert-scale and is given in the table 4. From feedback, it is found that

- 100% students agreed that Lab-handout provided for the course Digital Technique was helpful
- 94% students agreed that Guidelines provided in Lab- handouts helped you to complete the assignment.
- 94% students agreed that Theory part given in the handout was useful to clear the concept about an experiment
- 92% Handout was supportive document to encourage for accomplishment of assignments
- 94% Overall handout enriched our interest in implementation of Lab Assignments
- 100% students agreed that Handout was useful in writing the laboratory journal of this course
- 98% students agreed that Handout will be useful at the time of practical oral examination of this course
- 98% students agreed that Handouts helped you in effective implementation of the assignments on time
- 100% students like this learning.

Table 4: Student's Feedback related to the Handouts of Digital Technique

Sr. #		Strongly agree	Agree	Disagree	Strongly disagree
1	Lab-handout provided for the course Digital Technique was helpful.	58%	42%	0%	0%
2	Guidelines provided in Lab- handouts helped you to complete the assignment.	52%	42%	6%	0%
3	Theory part given in the handout was useful to clear the concept about an experiment	58%	36%	6%	0%
4	Handout was supportive document to encourage for accomplishment of assignments	42%	50%	8%	0%
5	Overall handout enriched our interest in implementation of Lab Assignments	40%	54%	6%	0%
6	Handout was useful in writing the laboratory journal of this course	64%	36%	0%	0%
7	Handout will be useful at the time of practical oral examination of this course	46%	52%	2%	0%
8	Handouts helped you in effective implementation of the assignments on time	48%	50%	2%	0%
9	Did you like this handout based learning (HBL)?	Yes=100%			

7. Conclusions

This paper explains and proves the use of handouts in teaching-learning process. Handouts, for each course explained here which is useful as guided document to the students to complete the given problem statement, enhanced their understanding and encouraged them to follow the guidelines. In this, HBL for Mobile Application Development and Digital Technique is explained in detail. The handouts designed are open to all to use for these courses. HBL incorporate active learning during lab session and improves decision making, critical thinking and problem solving skill. These handouts can be incorporated with the any ICT (Information Communication Technology) tool like MOODLE (Modular Object Oriented Dynamic Learning Environment), Faculty/ Course WebPages.

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