AN OPTIMIZATION OF CLASS SCHEDULING PROBLEM IN THE COLLEGE OF ENGINEERING AT ALASALA

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Abstract - Class scheduling task is a common problem in universities and colleges. It would be difficult or impossible for a course timetabling committee to assign courses manually with different number of students registered for offered courses under a number of faculty members, and various capacities of classrooms and laboratories. The assigning process must meet all of the educational and academic goals in order to satisfy both students and lecturers. There are a lot of limitations such as time slot, courses conflicts, available rooms, instructors' preferences, and more. The problem of class scheduling in the College of Engineering at Alasala is formulated in the form of binary integer linear programming. The objective function of the model is to maximize the number of sections requested by students for a semester without conflicts. In this paper, the results show a significant improvement of manual scheduling using an efficient optimization model tested with LINGO software.

Keywords - Course Schedule, Optimization, Integer Programming, LINGO.

I. INTRODUCTION

One of the significant and critical activities in the field of educational and operational research is the class scheduling problem. It is a combinatorial problem which consists of scheduling a set of courses with a number of rooms and time slots. For college students, appropriate time management in academics is key to their success in their studies. A lack of time management behavior can affect their overall academic performance [1].
According to the literature, there are five basic elements of a university course timetable, which are courses, rooms, time, lecturers, and students (Daskalaki, Birbas & Housos, 2004; Aziz & Aizam, 2018). The complexity of the timetabling problem increases with the change of these elements:

1. Courses: The specific subjects to be scheduled.
2. Rooms: The physical locations with specific capacities and equipment.
3. Time: The available time slots and days for classes.
4. Lecturers/Professors: The teaching staff with specific availability and course assignments.
5. Students: The groups or individual students that need to attend courses without conflicts.

Linear programming (LP) optimization is known for beeing applied in different areas, such as in manufacturing, food distribution, and renewable energy among others [2-4]. Scheduling shift changes, run times, maintenance intervals, and more alike can also use LP to optimize their operations. These allow organizations to maximize or minimize their resources, costs, expenses, and time management.
The first table explains the process of solving class scheduling problem through integer linear programming.

Step 1	List the rules and requirements for the timetable.
Step 2	Identify the hard and soft constraints.
Step 3	Convert the hard and soft constraints into mathematical model.
Step 4	Validate the model in optimization solvers.

Table 1: Steps to solve a university Class Scheduling through integer programming

The main stakeholders involved in class scheduling are instructors and students to find two types of constraints: hard constraints and soft constraints (Babaei, Karimpour & Hadidi, 2015). Hard constraints are strict requirements that any valid solution must satisfy; a violation makes the solution infeasible. For instance, a professor cannot give more than one lecture at a specific timeslot. Soft constraints could be satisfied as much as possible to ensure the quality of a timetable, such as lecturers' preferences (MirHassani & Habibi, 2013). Then, all of constraints will be transformed into the constraints in the mathematical integer programming model, while the soft constraints are usually inserted in the objective function in that model (MirHassani & Habibi, 2013). After the formulation of the complete model, it will be validated in optimization solvers with either real-world data or simulated data.

II. PROBLEM STATEMENT

The problem of class scheduling in the college of Engineering at Alasala consists of preparing a set of courses with a number of rooms and time slots. There are five engineering departments (industrial, mechanical, electrical, civil, and architectural) that face a difficult scheduling problem. According study plans of bachelor's degrees, there are eight semesters or four years to be completed by students. They can

register for different courses using an internal Student Information System (SIS) and pay the courses fees online. A course section is a specific instance or grouping of students within a broader subject (course), differentiated by time, instructor and format (online, hybrid, in-person). The task of opening new sections in the beginning of semester is manually done by each head of department. This activity is generally based on the idea of opening sections for courses of semesters 1, 3, 5, and 7 in the beginning of the academic year (August-September). For the second semester (December-January), they decide to open sections for courses of semesters 2, 4, 6, and 8. Each semester is planned to offer to students 14-18 registered credit hours (CR) which correspond to 5-6 courses. But there are many students graduated from others institutions and having equivalence of certain courses, it becomes impossible for them to register for these numbers of credit hours. Thus, the heads of department try to open specific sections for these students in order to help them to be graduated in time. A big problem starts immediately due to many reasons such as time conflict of courses and availability of rooms, laboratories, and professors. The long process of rescheduling and changing the time of sections, and classrooms leads to a waste of time and energy.

The goal of this present research paper is to assign each course to a room and a time slot by maximizing the number of course assignment and minimizing the time conflict according to a list of constraints. There are two types of constraints that need to be satisfied:

A. Hard Constraints

The following list of hard constraints must be satisfied for the solution to be valid:

- Each course is assigned to only one instructor.
- Each course is held in one room and one specific time slots.
- Each course must be taught by exactly one lecturer.
- An instructor is assigned to time slots when he or she is available.
- The number of courses taught by a lecturer shall not exceed the maximum workload.
- Instructors are limited to teaching only the subjects in which they are specialized.
- According to the Alasala regulations, there is a certain number of courses in each semester for each bachelor's program with specified credits hours (CR).

B. Soft Constraints

The following list of soft constraints should be satisfied for the solution to be valid:

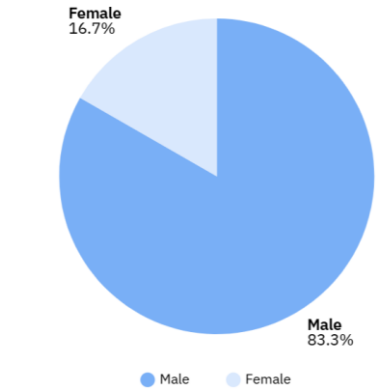
• An instructor may wish to avoid teaching during certain time slots.

III. DATA COLLECTION AND ANALYSIS

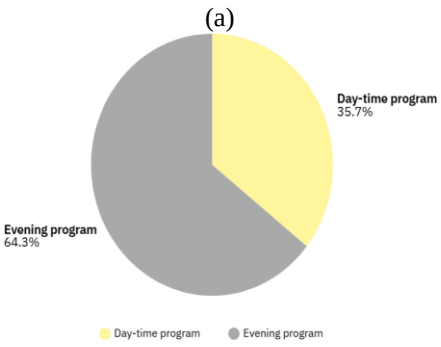
This study uses integer linear programming for the model. Linear programming allows us to formulate mathematical model based on real world problem. The data is to be analyzed for the design of a LP model which is based on information collected from an online survey (Google Forms) sent to more than 1000 students (male and female) for both daytime program and evening program. It asks the following:

- Which courses are you unable to register for?
- Why can't you register?

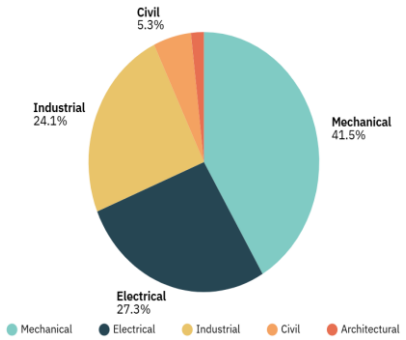
The responses of students are analyzed as follows (see Figure 1 and Table 1). The total number of responses is 677. It is found that the percentage of the course registration problems are 41.2% (I can’t see courses) due to non-scheduling of courses yet, 30.6% (Conflict) due to the time conflict in the students schedules, 19.5% (Room full) because the classes have reached its maximum capacities, and 8.7% (Course not available) due to non-opening of courses sections yet by the heads of department.



(a)



(b)



(c)



(d)

Figure 1: Summary of students' responses

Table 1 summarizes the number of students unable to register for courses. The numbers greater than 10 are in bold. The actual corrective actions to help the students are opening new sections and change the timings under a pressure of work and time. This was so difficult due to the generation of others time conflicts and unavailability of instructors in many cases.

SECOND SEMESTER 2025/2026-COLLEGE OF ENGINEERING	Male			Female		
Number of students having problems (time conflict, full class, etc.) for each COURSE CODE.	Day	Evening	Total	Day	Evening	Total
ARAB101	5	7	12	2	0	2
ARAB102	1	2	3	5	1	6
CMP101	11	5	16	3	3	6
ENGL101	13	18	31	3	0	3
ENGL102	4	7	11	1	1	2
ENGL201	4	11	15	0	3	3
ISLM101	3	15	18	3	2	5
ISLM102	5	7	12	5	0	5
SKL201	4	13	17	2	3	5
SKL301	0	1	1	1	0	1
SKL401	1	1	2	2	0	2
PE101	3	15	18	5	1	6
CHEM101	6	12	18	5	5	10
EGR101	7	12	19	5	1	6
EGR200	5	63	68	5	1	6
EGR201	7	31	38	5	2	7
EGR202	1	10	11	2	2	4
EGR301	3	9	12	2	1	3
EGR310	9	58	67	1	1	2
EGR401	19	38	57	1	0	1
MATH101	10	25	35	2	0	2
MATH102	16	18	34	5	3	8
MATH222	7	55	62	10	4	14
MATH301	1	5	6	0	0	0
MATH221	3	16	19	6	0	6
MATH303	4	40	44	4	1	5
PHY101	13	16	29	3	0	3
PHY102	9	70	79	19	7	26
AE211	0	1	1	0	1	1
AE315	0	0	0	0	0	0
AE320	0	0	0	1	1	2

AE497	0	0	0	0	0	0
AE5XX Elective I	0	0	0	0	0	0
AE5XX Elective II	0	0	0	0	0	0
AE311	0	0	0	0	0	0
AE411	0	0	0	0	0	0
ARCH503	0	0	0	0	0	0
CE201/AE201	0	4	4	1	1	2
CE203	0	1	1	0	0	0
CE204	2	0	2	0	0	0
CE301	0	1	1	1	1	2
CE302	1	1	2	1	0	1
CE304	1	3	4	1	0	1
CE305	1	2	3	0	0	0
CE306	1	0	1	0	0	0
CE307	0	3	3	0	0	0
CE401	0	0	0	0	0	0
CE402	0	2	2	0	0	0
CE404	1	5	6	0	1	1
CE405	1	0	1	0	0	0
CE406	2	5	7	0	0	0
CE499	0	1	1	0	0	0
CE4XX IE Elective I	1	0	1	0	0	0
CE4XX IE Elective II	2	1	3	0	0	0
EE200	2	12	14	1	0	1
EE201	8	9	17	1	0	1
EE210	1	6	7	1	0	1
EE300	1	3	4	1	0	1
EE301	1	2	3	0	0	0
EE302	1	1	2	0	0	0
EE303	3	4	7	1	0	1
EE300	1	16	17	0	0	0
EE304	1	1	2	5	0	5
EE306	4	6	10	0	0	0
EE306	4	11	15	2	0	2
EE305	4	0	4	6	0	6
EE401	2	14	16	2	0	2
EE402	0	2	2	0	0	0
EE499	0	0	0	2	0	2
EE4XX	2	2	4	2	0	2
EE4XX	4	3	7	4	0	4
ELC308	0	0	0	1	0	1
IE201	2	4	6	1	1	2
IE202	2	7	9	3	1	4
IE203	2	0	2	11	1	12

IE204	8	19	27	4	0	4
IE301	1	4	5	3	5	8
IE302	0	3	3	3	0	3
IE303	4	6	10	8	1	9
IE304	0	2	2	3	0	3
IE305	11	19	30	4	1	5
IE306	1	0	1	1	1	2
IE401	9	13	22	0	1	1
IE402	4	10	14	1	2	3
IE403	2	9	11	0	0	0
IE406	0	1	1	0	1	1
IE499	0	0	0	0	0	0
IE4XX Elective I	3	6	9	0	0	0
IE4XX Elective II	3	11	14	0	0	0
ME301	4	17	21	1	0	1
ME302	3	10	13	1	0	1
ME303	6	31	37	4	0	4
ME304	17	27	44	4	2	6
ME305	2	14	16	0	0	0
ME306	2	0	2	3	2	5
ME307	4	25	29	1	0	1
ME308	8	8	16	1	0	1
ME309	3	12	15	0	0	0
ME310	10	11	21	0	0	0
ME401	5	7	12	1	0	1
ME402	5	7	12	0	0	0
ME403	10	6	16	0	0	0
ME499	1	0	1	0	0	0
ME4XX I	1	5	6	0	0	0
ME4XX II	4	10	14	0	0	0
ME4XX III	1	13	14	1	0	1
MEC434	4	0	4	0	0	0
ME453	3	4	7	0	0	0
XXXX (Elective)	2	11	13	7	1	8

Table 1: The number of students having problems in course registration.

These results confirm the need of the optimization of the class problem scheduling in the College of Engineering at Alasala using the integer linear programming with an optimization modeling tool like LINGO software.

IV. MODEL FORMULATION

For more details, the formulation of a mathematical model of the problem of course scheduling is applied in this research work in the department of Industrial Engineering (IE) for the evening classes. The actual proposed schedule will be a reference to be compared with the final optimal solution.

The number of IE courses according to the study plan is 16 and there are four instructors for teaching evening classes.

Table 2 shows a manual scheduling of the offered courses for the second semester (January- June 2026). The total number of hours (47 hours) assigned to the instructors (1, 2, 3, and 4).

Course Code	Course Title	Instructors			
		#1	#2	#3	#4
1. IE201	Industrial Project Management	3			
2. IE202	Process & Systems				3
3. IE203	Analysis & Design of Production Systems		4		
4. IE204	Operations Research		3		
5. IE301	Supply chains & Industrial processes	3			
6. IE302	Design for Assembly & Automation			3	
7. IE303	Human Factors & Safety			3	
8. IE304	Engineering Reliability & Maintenance				3
9. IE305	Industrial Machines Operation & Control		3		
10. IE306	Quality Control and Industrial Statistics				3
11. IE401	Facilities Design			3	
12. IE402	Capstone Project I			2	
13. IE403	Industrial Processes Simulation		3		
14. IE404	Special Topics in Engineering	3			
15. IE406	Capstone Project II			2	
16. IE415	Six Sigma			3	
	Total number of hours per instructor	9 h	13 h	16 h	9 h

Table 2: Manually Class scheduling in the IE department (case study)

The actual instructors' schedules are shown in Table 3. The classes start at 17:00. There are 4 classrooms designed for teaching.

Instructor#1	Sun.	Mon.	Tue.	Wed.	Thu.
17:00		IE301 Room 2		IE201 Room 1	
18:00	IE404 Room 1	IE301 Room 2		IE201 Room 1	
19:00	IE404 Room 1	IE301 Room 2		IE201 Room 1	
20:00	IE404 Room 1				
21:00					
22:00					

Table 3: Actual instructor's schedules

Instructor#2	Sun.	Mon.	Tue.	Wed.	Thu.
17:00		IE203 Room 3	IE403 Room 1	IE203 Room 3	
18:00		IE203 Room 3	IE403 Room 1	IE203 Room 3	
19:00		IE403 Room 3	IE204 Room 1	IE204 Room 3	
20:00			IE204 Room 1		

21:00				IE305 Room 3	
22:00		IE305 Room 3		IE305 Room 3	

Table 3: Actual instructor's schedules

Instructor#3	Sun.	Mon.	Tue.	Wed.	Thu.
17:00	IE401 Room 3	IE406 Room 1	IE303 Room 2	IE401 Room 2	
18:00		IE406 Room 1	IE303 Room 2	IE401 Room 2	IE303 Room 1
19:00	IE302 Room 3				
20:00	IE302 Room 3	IE415 Room 1		IE415 Room 2	IE302 Room 1
21:00	IE402 Room 3	IE415 Room 1			
22:00	IE402 Room 3				

Table 3: Actual instructor's schedules

Instructor#4	Sun.	Mon.	Tue.	Wed.	Thu.
17:00			IE406 Room 4	IE304 Room 4	IE202 Room 4
18:00			IE406 Room 4	IE304 Room 4	IE304 Room 4
19:00					IE406 Room 4
20:00			IE202 Room 4		
21:00			IE202 Room 4		
22:00					

The following notation is used in the LP formulation model for the course timetabling problem:
Decision Variables: Binary indexed variables X_{ijkl} where:
i = day number (5 days in total).
j = time slot number (15 slots in total).
k = classroom number (5 classrooms in total).
l= course number (16 courses in total).
X_{ijkl} is equal to 1 if a course, classroom, day, and timeslot combination is selected and 0 otherwise. For example, for the schedule of the first instructor, the combination X(i=2, j=17, k=2, l=5) means on Monday at 17:00 in the classroom number 4, we teach the course number 5 (IE301 Supply Chains). A second example for the second instructor is X(i=3, j=20, k=3, l=4)=1 means on Tuesday at 20:00 in classroom number 3, we teach the course number 4 (IE204 Operations Research).

The constraints of the proposed LP model are summarized as follows:

- The objective function of the model is to maximize the number of course assigned as shown in the following equation.

$$MaxZ = \sum_i \sum_j \sum_k \sum_l x_{ijkl}$$

- The first constraint is to ensure that every course section is assigned to only one instructor. The first instructor teaches 2 courses: IE201 (l=1), IE301 (l=5), and IE404 (l=14). Each one requires 3 hours as time for teaching.

$$\sum_i \sum_j \sum_k x_{ijk1} = 3$$
$$\sum_i \sum_j \sum_k x_{ijk5} = 3$$
$$\sum_i \sum_j \sum_k x_{ijk14} = 3$$

The second instructor teaches 5 courses: IE203 (l=3), IE204 (l=4), IE305 (l=9) and IE403 (l=13).

$$\sum_i \sum_j \sum_k x_{ijk3} = 4$$
$$\sum_i \sum_j \sum_k x_{ijk4} = 3$$
$$\sum_i \sum_j \sum_k x_{ijk9} = 3$$
$$\sum_i \sum_j \sum_k x_{ijk13} = 3$$

The third instructor teaches 5 courses: IE302 (l=6), IE303 (l=7), IE401 (l=11), IE402 (l=12), IE406 (l=15)

and IE415 (l=16).

$$\sum_i \sum_j \sum_k x_{ijk2} \le 3$$

$$\sum_i \sum_j \sum_k x_{ijk7} \le 3$$

$$\sum_i \sum_j \sum_k x_{ijk11} \le 3$$

$$\sum_i \sum_j \sum_k x_{ijk12} \le 2$$

$$\sum_i \sum_j \sum_k x_{ijk15} \le 2$$

$$\sum_i \sum_j \sum_k x_{ijk16} \le 3$$

The fourth instructor teaches 3 courses: IE202 (L=2), IE304 (l=8), and IE306 (l=10).

$$\sum_i \sum_j \sum_k x_{ijk2} \le 3$$

$$\sum_i \sum_j \sum_k x_{ijk8} \le 3$$

$$\sum_i \sum_j \sum_k x_{ijk10} \le 3$$

- The second constraint is to ensure that every lecture is assigned to only one room at a given time ($\forall$l).

$$\sum_i \sum_j \sum_k x_{ijkl} \le 1$$

- The third constraint is to ensure that the number of lectures taught by a lecturer shall not exceed the maximum daily workload. In our case, it is 4 hours for any evening from Sunday to Thursday ($\forall$i).

$$\sum_j \sum_k (x_{ijk1} + x_{ijk5}) \le 4$$

$$\sum_j \sum_k (x_{ijk3} + x_{ijk4} + x_{ijk8} + x_{ijk9} + x_{ijk13}) \le 4$$

$$\sum_j \sum_k (x_{ijk6} + x_{ijk7} + x_{ijk11} + x_{ijk12} + x_{ijk16}) \le 4$$

$$\sum_j \sum_k (x_{ijk2} + x_{ijk8} + x_{ijk10}) \le 4$$

- The last constraint means that an instructor may wish to avoid teaching during certain time slots. In our case study, the first instructor wishes to be free on Thursday and the second instructor requests to have Sunday without lectures to complete the tasks of the department. The following mathematical equations model this soft constraint:

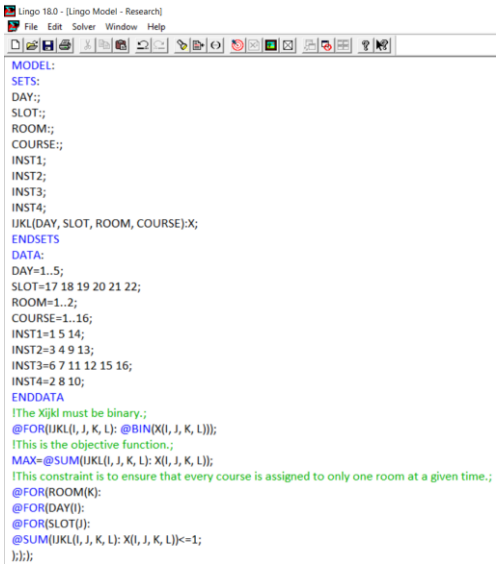
$$\sum_j \sum_k (x_{5jk1} + x_{5jk5} + x_{5jk14}) = 0 \quad (\forall k,j)$$

$$\sum_j \sum_k (x_{1jk3} + x_{1jk4} + x_{1jk9} + x_{1jk13}) = 0 \quad (\forall k,j)$$

V. LINEAR PROGRAMMING MODEL IMPLEMENTATION IN LINGO

One of LINGO's most powerful features is its mathematical modeling language. LINGO's modeling language lets you express your problem in a natural manner that is very similar to standard mathematical notation.

First, the objective function is constructed as mentioned before (maximize the number of assigned courses) with a 4-dimensional decision variable X(i, j, k, l) commonly used for complex, multi-indexed optimization problems involving four sets (see figure 2).

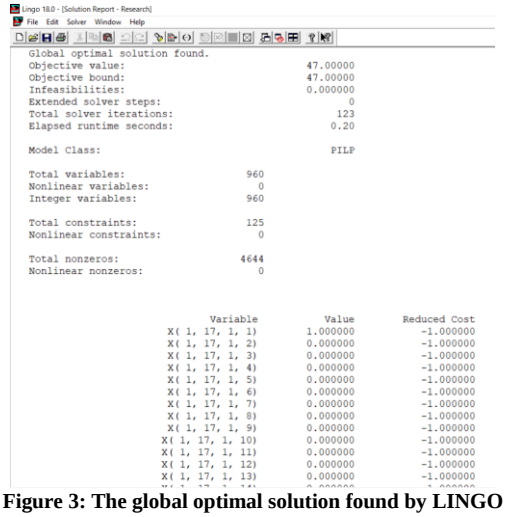


```
MODEL:
SETS:
DAY:;
SLOT:;
ROOM:;
COURSE:;
INST1;
INST2;
INST3;
INST4;
IJKL(DAY, SLOT, ROOM, COURSE):X;
ENDSETS
DATA:
DAY=1..5;
SLOT=17 18 19 20 21 22;
ROOM=1..2;
COURSE=1..16;
INST1=1 5 14;
INST2=3 4 9 13;
INST3=6 7 11 12 15 16;
INST4=2 8 10;
ENDDATA
!The Xijkl must be binary.;
@FOR(IJKL(I, J, K, L): @BIN(X(I, J, K, L)));
!This is the objective function.;
MAX=@SUM(IJKL(I, J, K, L): X(I, J, K, L));
!This constraint is to ensure that every course is assigned to only one room at a given time.;
@FOR(ROOM(K):
@FOR(DAY(I):
@FOR(SLOT(J):
@SUM(IJKL(I, J, K, L): X(I, J, K, L)<=1;
));));
```

Figure 2: LP modeling using LINGO (part of code)

VI. RESULTS AND DISCUSSION

LINGO 18 provides the report shown in figure 3 with all combinations of X(i, j, k, l). The total number of variable is 960 under 125 constraints and the software generates an optimal solution with 47 hours as an objective value. That means all lectures are scheduled as per the requirement mentioned above in Table 2.



```
Global optimal solution found.
Objective value:                              47.00000
Objective bound:                              47.00000
Infeasibilities:                              0.000000
Extended solver steps:                               0
Total solver iterations:                           123
Elapsed runtime seconds:                          0.20

Model Class:                                      PILP

Total variables:                   960
Nonlinear variables:                 0
Integer variables:                 960

Total constraints:                 125
Nonlinear constraints:               0

Total nonzeros:                   4644
Nonlinear nonzeros:                  0

                     Variable           Value        Reduced Cost
                  X( 1, 17, 1, 1)    1.000000          -1.000000
                  X( 1, 17, 1, 2)    0.000000          -1.000000
                  X( 1, 17, 1, 3)    0.000000          -1.000000
                  X( 1, 17, 1, 4)    0.000000          -1.000000
                  X( 1, 17, 1, 5)    0.000000          -1.000000
                  X( 1, 17, 1, 6)    0.000000          -1.000000
                  X( 1, 17, 1, 7)    0.000000          -1.000000
                  X( 1, 17, 1, 8)    0.000000          -1.000000
                  X( 1, 17, 1, 9)    0.000000          -1.000000
                 X( 1, 17, 1, 10)    0.000000          -1.000000
                 X( 1, 17, 1, 11)    0.000000          -1.000000
                 X( 1, 17, 1, 12)    0.000000          -1.000000
                 X( 1, 17, 1, 13)    0.000000          -1.000000
```

Figure 3: The global optimal solution found by LINGO

The result from the report should be copied to Microsoft Excel table to export only the data if X(i, j, k, l)=1. With the translated result in Excel sheet, the schedule is formed (see Table 3). For example, X(1 17 1 1) means that on Sunday at 17:00 in Room 1, the first instructor teaches class IE201 "Industrial Project Management".

Variable X(i, j, k , l)						Optimal course scheduling				
X(	1	17	1	1	)	SUN.	17:00	ROOM 1	IE201	
X(	1	18	1	1	)	SUN.	18:00	ROOM 1	IE201	
X(	1	19	1	1	)	SUN.	19:00	ROOM 1	IE201	
X(	1	20	1	5	)	SUN.	20:00	ROOM 1	IE301	
X(	2	21	1	5	)	MON.	21:00	ROOM 1	IE301	
X(	2	22	1	5	)	MON.	22:00	ROOM 1	IE301	
X(	3	21	1	14	)	TUE.	21:00	ROOM 1	IE404	
X(	3	22	1	14	)	TUE.	22:00	ROOM 1	IE404	
X(	4	21	1	14	)	WED.	21:00	ROOM 1	IE404	First instructor
X(	2	17	1	3	)	MON.	17:00	ROOM 1	IE203	
X(	2	18	1	3	)	MON.	18:00	ROOM 1	IE203	
X(	2	19	1	3	)	MON.	19:00	ROOM 1	IE203	
X(	2	20	1	3	)	MON.	20:00	ROOM 1	IE203	
X(	3	17	1	4	)	TUE.	17:00	ROOM 1	IE204	
X(	3	18	1	4	)	TUE.	18:00	ROOM 1	IE204	
X(	3	19	1	4	)	TUE.	19:00	ROOM 1	IE204	
X(	3	20	1	9	)	TUE.	20:00	ROOM 1	IE305	
X(	4	17	1	9	)	WED.	17:00	ROOM 1	IE305	
X(	4	18	1	9	)	WED.	18:00	ROOM 1	IE305	
X(	4	19	1	13	)	WED.	19:00	ROOM 1	IE403	
X(	4	20	1	13	)	WED.	20:00	ROOM 1	IE403	
X(	5	17	1	13	)	THU.	17:00	ROOM 1	IE403	Second instructor
X(	1	20	2	6	)	SUN.	20:00	ROOM 2	IE302	
X(	1	21	2	6	)	SUN.	21:00	ROOM 2	IE302	
X(	1	22	2	6	)	SUN.	22:00	ROOM 2	IE302	
X(	2	17	2	7	)	MON.	17:00	ROOM 2	IE303	
X(	2	18	2	7	)	MON.	18:00	ROOM 2	IE303	
X(	2	19	2	7	)	MON.	19:00	ROOM 2	IE303	
X(	3	20	2	11	)	TUE.	20:00	ROOM 2	IE401	
X(	3	21	2	11	)	TUE.	21:00	ROOM 2	IE401	
X(	3	22	2	11	)	TUE.	22:00	ROOM 2	IE401	
X(	4	17	2	12	)	WED.	17:00	ROOM 2	IE402	
X(	4	18	2	12	)	WED.	18:00	ROOM 2	IE402	
X(	4	19	2	15	)	WED.	19:00	ROOM 2	IE406	
X(	4	20	2	15	)	WED.	20:00	ROOM 2	IE406	
X(	5	17	2	16	)	THU.	17:00	ROOM 2	IE415	
X(	5	18	2	16	)	THU.	18:00	ROOM 2	IE415	
X(	5	19	2	16	)	THU.	19:00	ROOM 2	IE415	Third instructor
X(	1	17	2	2	)	SUN.	17:00	ROOM 2	IE202	
X(	1	18	2	2	)	SUN.	18:00	ROOM 2	IE202	
X(	1	19	2	2	)	SUN.	19:00	ROOM 2	IE202	
X(	2	20	2	8	)	MON.	20:00	ROOM 2	IE304	
X(	2	21	2	8	)	MON.	21:00	ROOM 2	IE304	
X(	2	22	2	8	)	MON.	22:00	ROOM 2	IE304	
X(	3	17	2	10	)	TUE.	17:00	ROOM 2	IE306	
X(	3	18	2	10	)	TUE.	18:00	ROOM 2	IE306	
X(	3	19	2	10	)	TUE.	19:00	ROOM 2	IE306	Fourth instructor

Table 3: Summary of results of course scheduling

According to the Table 3, all hard constraints are satisfied and all courses are scheduled in the appropriate timeslots and rooms. It is shown that there are no times or locations conflict for all 47 hours lectures for the instructors. In addition, the optimal solution is reached with only 2 classrooms instead of 4.

In addition, the two soft constraints are met. Therefore, the first instructor has Thursday off and the second one has Sunday off. The total number of

mandatory course hours assigned for each instructor is not more than 4 hours daily in the evening.

VII. CONCLUSION

This paper offers optimization of class scheduling. The courses are suited to appropriate rooms and to specific timing. The 4-dimensional analysis applied to the data of the industrial engineering department shows that there is a significant improvement of manual scheduling using an efficient optimization model. The LINGO solution report indicates that all constraints are fully satisfied. This work is restricted to the scheduling of 16 courses for 4 instructors in two rooms. A larger number of courses for the entire college at Alasala may pose more challenges to the research.

REFERENCES

[1] K. B. Nadinloyi, N. Hajloo, N. S. Garamaleki, and H. Sadeghi, "The Study Efficacy of Time Management Training on Increase Academic Time Management of Students," Procedia - Soc. Behav. Sci., vol. 84, pp. 134–138, 2013, doi: 10.1016/j.sbspro.2013.06.523.

[2] A. M. O. Galindo, E. P. Dadios, R. K. C. Billones and I. C. Valenzuela, "Cost Optimization for the Allocation, Production, and Distribution of a Plastic Manufacturing Company Using Integer Linear Programming," 2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 2021, pp. 1-6, doi: 10.1109/HNICEM54116.2021.9731804.

[3] I. J. C. Valencia, E. P. Dadios and R. K. C. Billones, "A Maximization Model for Food Aid Distribution using Integer Linear Programming," 2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 2021, pp. 1-6, doi: 10.1109/HNICEM54116.2021.9732003.

[4] V. D. G. Balcita, A. T. A. Bejar, T. P. P. Goy, R. K. C. Billones and E. P. Dadios, "Optimizing the Allocation of Renewable Energy Generation and Energy Consumption of Power Plants in the Philippines using Linear Programming," 2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 2021, pp. 1-6, doi: 10.1109/HNICEM54116.2021.9732024.

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