People’s Republic of Bangladesh
Technical and Madrasah Education Division
Directorate of Technical Education

People’s Republic of Bangladesh

Project for Improvement of Technical Education for Industrial Human Resources Development

Project Completion Report
(1st Period)

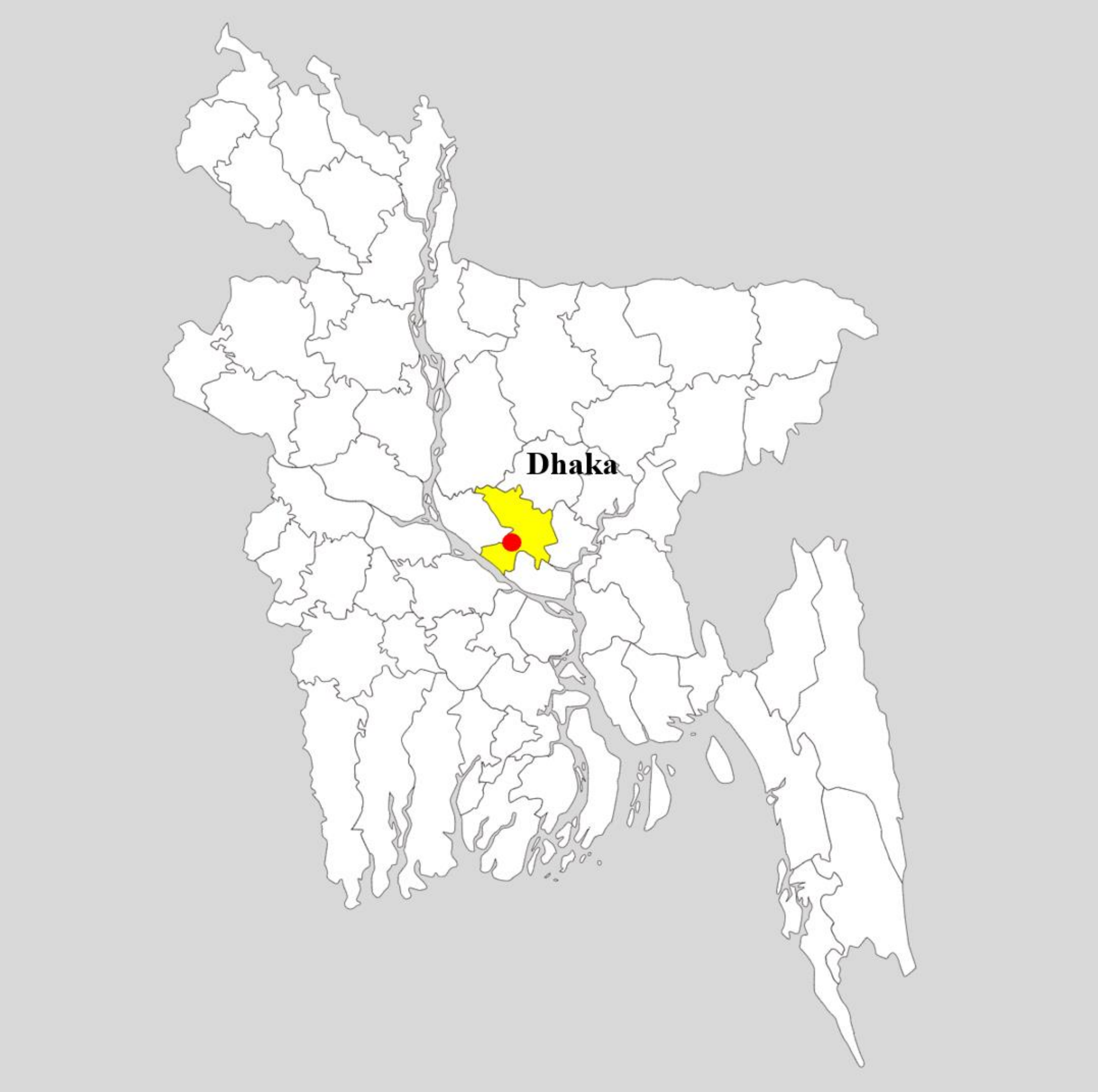
April 2022

Japan International Cooperation Agency

IC Net Limited

HM
JR
22-046

MAP



Created from https://n.freemap.jp/st/list.html

Currency exchange rate (February 2022)

USD 1.00 = JPY 115.5550

BDT 1.00 (BDT: Bangladesh Taka) = JPY 1.371680

Project Photographs

Common Photos

1st JCC Meeting

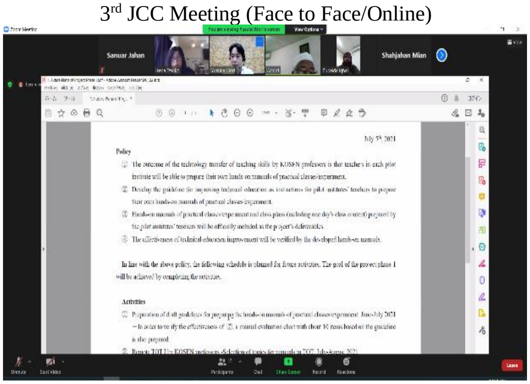
The Second Joint Coordinating Committee (JCC)
April5th, 2021,11:00am – 12:00pm
Zoom Online Platform

No.	TIME	ACTIVITY	Person In Charge
1	11:00 - 11:05	Opening Remarks	Director General, DTE
2	11:05 - 11:30	Report on Activities from September 2019 to January 2021	–
	(11:05 - 11:25)	Progress of Activities from September 2019 to January 2021	Mr. Md. Jahangir Alam Director (Planning & Development)
	(11:25 - 11:30)	List of Equipment Provided by the Project	Mr. Yusuke Mori Deputy Chief Advisor of the project
3	11:30 - 11:40	Planned Activities from February 2021 to July 2021	M. Etsuko Ikeda Chief Advisor of the project
4	11:40-11:50	Target Numbers of the PDM Indicators	Mr. Yusuke Mori Deputy Chief Advisor of the project
5	11:50-11:55	Q&A Plan on the 3rd JCC	Mr. Md. Jahangir Alam Director (Planning & Development)
6	11:55- 12:00	Closing Remarks	Representative of JICA

2nd JCC Meeting (Online)

3rd JCC Meeting (Face to Face/Online)

1st Working Group Meeting



July 5th, 2021

Policy

① The outcome of the technology transfer of teaching skills by KOSEN professors is that teachers in each pilot institute will be able to prepare their own hands-on manuals of practical classes/experiment.

② Develop the guideline for improving technical education as instructions for pilot institutes' teachers to prepare their own hands-on manuals of practical classes/experiment.

③ Hands-on manuals of practical classes/experiment and class plans (including one day's class content) prepared by the pilot institutes' teachers will be officially included as the project's deliverables.

④ The effectiveness of technical education improvement will be verified by the developed hands-on manuals.

In line with the above policy, the following schedule is planned for future activities. The goal of the project phase 1 will be achieved by completing the activities.

Activities

① Preparation of draft guidelines for preparing the hands-on manuals of practical classes/experiment: June-July 2021
—In order to verify the effectiveness of ③, a manual evaluation chart with about 10 items based on the guideline is also prepared.

② Remote TOT 1 by KOSEN professors -Selection of topics for manuals in TOT: July-August 2021

6th Working Group Meeting (Online)

Training in Japan (Tsuruoka KOSEN)

Training in Japan (Tsuruoka KOSEN)

Training in Japan (Tsuruoka KOSEN)

Activities for Output 1


Selection of a model subject by the working group

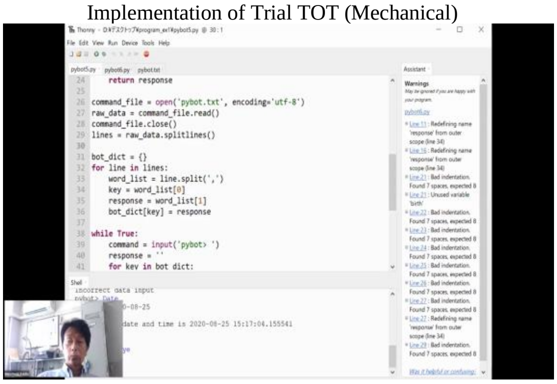
Development of an action plan by the working group

Activities for Output 2


Workshop for hands-on manual development (Online)


Implementation of Trial TOT (Mechanical)


Implementation of Trial TOT (Electronics)



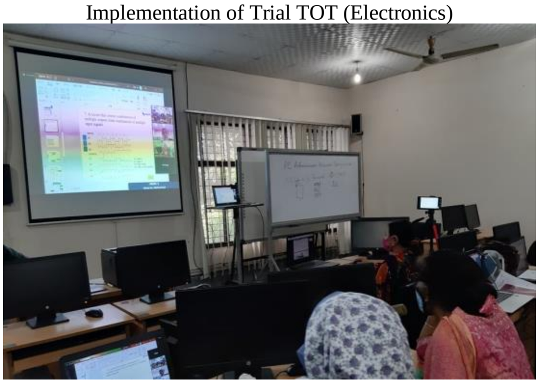
```
    return response

command_file = open('pybot.txt', encoding='utf-8')
raw_data = command_file.read()
command_file.close()
lines = raw_data.splitlines()

bot_dict = {}
for line in lines:
    word_list = line.split(',')
    key = word_list[0]
    response = word_list[1]
    bot_dict[key] = response

while True:
    command = input('pybot> ')
    response = ''
    for kev in bot dict:
```

```
incorrect data input
pybot> Date
0-08-25
date and time is 2020-08-25 15:17:04.155541
```

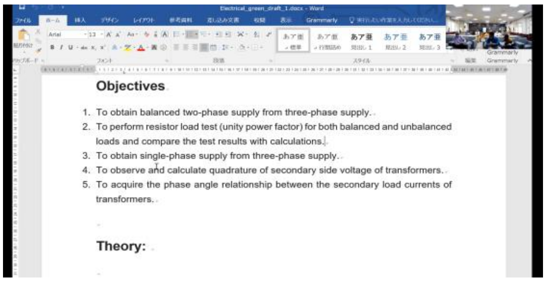
Warnings
May be ignored if you are happy with your program.
pybot5.py
- Line 11 : Redefining name 'response' from outer scope (line 34)
- Line 16 : Redefining name 'response' from outer scope (line 34)
- Line 21 : Bad indentation. Found 7 spaces, expected 8
- Line 21 : Unused variable 'birth'
- Line 22 : Bad indentation. Found 7 spaces, expected 8
- Line 23 : Bad indentation. Found 7 spaces, expected 8
- Line 24 : Bad indentation. Found 7 spaces, expected 8
- Line 25 : Bad indentation. Found 7 spaces, expected 8
- Line 26 : Bad indentation. Found 7 spaces, expected 8
- Line 27 : Bad indentation. Found 7 spaces, expected 8
- Line 27 : Redefining name 'response' from outer scope (line 34)
- Line 29 : Bad indentation. Found 7 spaces, expected 8

Was it helpful or confusing?

Implementation of 1st Remote TOT (Computer)


Implementation of 1st Remote TOT (Electronics)

Implementation of Competency Mapping Workshop



Objectives

1. To obtain balanced two-phase supply from three-phase supply.
2. To perform resistor load test (unity power factor) for both balanced and unbalanced loads and compare the test results with calculations.
3. To obtain single-phase supply from three-phase supply.
4. To observe and calculate quadrature of secondary side voltage of transformers.
5. To acquire the phase angle relationship between the secondary load currents of transformers.

Theory:

Workshop for reviewing the draft hands-on manuals

ToT of Hands on Manual Preparation

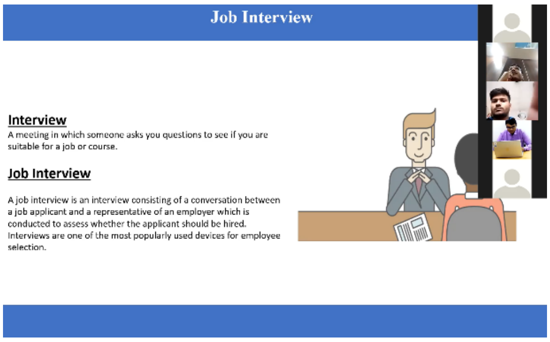
Conducted by: Green Team

Team Members:
Mr. Sujit Bikash Chakma
Ms. Lutfa Khanom
Ms. Afroja Begum

Topic: Looping in Python

Review of draft hands-on manuals by faculty members

Activities for Output 4



Job Interview

Interview

A meeting in which someone asks you questions to see if you are suitable for a job or course.

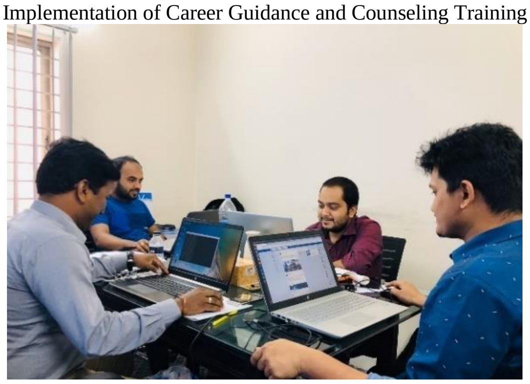
Job Interview

A job interview is an interview consisting of a conversation between a job applicant and a representative of an employer which is conducted to assess whether the applicant should be hired. Interviews are one of the most popularly used devices for employee selection.

Implementation of Online Job Placement Seminar

Implementation of Career Guidance and Counseling Training

Instruction for preparing an interview on an internship



Implementation of an internship

Online Industry-academia Collaboration Event

Between Japanese Companies and Polytechnic Institutes 202

Implemented by: Project for Improvement of Technical Education for Industrial Human Resources Development

For Students/Ex-students
- Please mute your microphone during the event
- Please turn off your camera during the event

March 23-24, 20

Online Industry-Academia Collaboration Event

Job Placement Cell-DPI

教育関連サイト

Operation of a job matching system through Facebook

List of Abbreviations

Abbreviation	Term in full
ADB	Asian Development Bank
BDT	Bangladeshi taka
BITAC	Bangladesh Industrial Technical Assistance Center
BTEB	Bangladesh Technical Education Board
COVID-19	Coronavirus disease 2019
DG	Director General
DPI	Dhaka Polytechnic Institute
DMPI	Dhaka Mohila Polytechnic Institute
DTE	Directorate of Technical Education
ERD	Economic Relation Division
EU	European Union
FBCCI	Federation of Bangladesh Chambers of Commerce and Industry
FD	Faculty Development
HoD	Head of Department
ILO	International Labour Organization
IMED	Implementation Monitoring and Evaluation Division
JCC	Joint Coordination Committee
JCIAD	Japanese Commerce and Industry Association in Dhaka
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JPY	Japanese yen
KOSEN	National Institute of Technology in Japan (Abbreviation for "**ko**utou **sen**mon gakkou")
LMS	Learning Management System
MCC	Model Core Curriculum
MoU	Memorandum of Understanding
PBL	Problem/Project-Based Learning
PD	Project Director
PDM	Project Design Matrix
SNS	Social Networking Service
TAPP	Technical Assistance Project Proforma
TMED	Technical and Madrasah Education Division
TSC	Technical School and College
TOT	Training of Trainers
TTTC	Technical Teachers Training College
TVET	Technical and Vocational Education and Training
USD	United States dollar

Table of Contents

1 Overview of the Project

1.1 Background

Bangladesh had set a target to become a middle-income country by 2021. In addition, it had positioned the education sector as an area of priority in the 7th Five Year Plan 2016-2020, which also advocated “accelerating growth and empowering citizens.”

Agriculture or food processing, IT, pharmaceuticals, leather, light engineering, and other industries are listed as priority areas in the National Industrial Policy 2016. Moreover, efforts are being made to diversify and upgrade these industries through the promotion of foreign and domestic investment by establishing special economic zones.

In 2016, an industrial human resource needs survey of 400 companies in Dhaka and Chittagong was conducted with the cooperation of the Ministry of Education’s Directorate of Technical Education (DTE), Bangladesh Technical Education Board (BTEB) and Bangladesh Industrial Technical Assistance Center (BITAC). The survey found that the lack of engineers was a major bottleneck for the advancement of industrialization. In addition, many of the 322 companies that responded to the survey were staffed by foreigners in middle and upper management positions. This indicates a harsh reality: that there is a lack of local middle managers and mid-level engineers, which has resulted in the employment of foreigners in those positions. To summarize, the number of engineers who can realize industrial diversification and high added value, and capable of improving productivity and creating new value through logical and critical thinking is limited. Therefore, a gap exists between the quality and quantity of industrial human resources in Bangladesh. To achieve a post-garment industry transformation in the industrial structure, the education sector must be developed to fill this gap.

1.2 Objective of the Project

The Overall Goal of this project is “A technical education model, which is developed at the pilot polytechnic institutes, becomes widely used at other polytechnic institutes.” To achieve this goal, the Project Purpose was set as follows: “Based on the needs of industry, human resources are nurtured at the pilot polytechnic institutes through improved technical education in the fields of electrical, electronics, mechanical and computer technologies.” Table 1 shows the detailed project structure including project activities.

Table 1. Structure of the project

Project Name	Project for Improvement of Technical Education for Industrial Human Resources Development
Overall Goal	A technical education model, which is developed at the pilot polytechnic institutes, becomes widely used at other polytechnic institutes.
Project Purpose	Based on the needs of industry, human resources are nurtured at the pilot

	polytechnic institutes through improved technical education in the fields of electrical, electronics, mechanical and computer technologies.
Outputs 1	Framework for improving technical education is consolidated at the pilot polytechnic institutes in Dhaka City. 1.1 Each pilot polytechnic institute in Dhaka City defines members, roles and responsibilities of the working group for improving technical education 1.2 The pilot polytechnic institutes in Dhaka City select model subjects for improving technical education. 1.3 The working group develops an action plan to improve technical education.
Output 2	Effectiveness of improved technical education is verified through implementation at the pilot polytechnic institutes in Dhaka City. 2.1 Based on the action plan, educational materials such as hands-on manuals of practical lessons for the selected subjects are developed. 2.2 Faculty members of the pilot polytechnic institutes together with TTTC participate in training for improving technical education. 2.3 Faculty members of the selected subjects conduct improved technical education. 2.4 The pilot polytechnic institutes verify the effectiveness of improved technical education. 2.5 Based on results of the verification, the pilot polytechnic institutes update the educational materials and formulate a guideline for improving technical education. 2.6 The guideline is shared with other polytechnic institutes through TTTC.
Output 3	An action plan for improving technical education is developed and implemented at a pilot polytechnic institute outside Dhaka City. 3.1 A polytechnic institute located outside Dhaka City is selected as a pilot polytechnic institute that improves technical education following the guideline developed and verified through the activities for Output 1 and 2. 3.2 The selected pilot polytechnic institute develops an action plan, referring to the guideline developed and verified through the activities for Output 1 and 2. 3.3 The selected pilot polytechnic institute implements and monitors the action plan. 3.4 The selected pilot polytechnic institute updates the action plan and educational materials.
Output 4	Collaboration between the pilot polytechnic institutes and industry is strengthened inside and outside Dhaka City. 4.1 The pilot polytechnic institutes in Dhaka City assign faculty members and develop action plans for promoting collaboration with industry. 4.2 The job placement cells at the pilot polytechnic institutes in Dhaka City collect information on private companies including job offer, employment and performance of the graduates. 4.3 The job placement cells of the pilot polytechnic institute in Dhaka City

	promote communications with industry through organizing lectures and/or recruitment seminars, coordinating internship programs and so forth. 4.4 The job placement cells at the pilot polytechnic institutes in Dhaka City enhance career counselling and matching support for employment. 4.5 The pilot polytechnic institute outside Dhaka City assigns faculty member(s) and develops an action plan for promoting collaboration with industry, referring to the activities at the pilot polytechnic institutes in Dhaka City and according to the local socio-economic environment of its own. 4.6 The pilot polytechnic institute outside Dhaka City implements the action plan for promoting collaboration with industry.

1.3 PDM Indicators

The first version of the target value for each PDM indicator was set at the 2nd JCC meeting, held in April 2021. Subsequently, the target values were partially revised to account for the impact of the COVID-19 pandemic. The first and revised target values are presented below, which were agreed upon at the 4th JCC meeting held in April 2022. The target values of PDM indicators for a pilot polytechnic institute outside Dhaka City will be agreed at the 5th JCC meeting to be held in the 2nd period. After that, the Record of Discussion will be officially signed for all the target values of PDM indicators agreed from the 2nd to 5th JCC meeting.

1. Overall Goal

PDM Indicator	Target Value (1st version)	Target Value (Revised version)
Indicator 1. Number of training events organized by DTE to disseminate the technical education model	The target number of training events is **[35]** in total.	No revision
Indicator 2. Number of polytechnic institutes and faculty members of polytechnic institutes that participate in the training	The target number of polytechnic institutes is **[44]**, and **[880]** faculty members will participate in the training.	No revision

Details of the revision:

・The target value of the Overall Goal was set up to five years after the completion of the project, and there was no revision at this time.

2. Project Purpose

PDM Indicator	Target Value (1st version)	Achievement as of the end of the 1st period	Target Value (Revised version)
Indicator 1. Satisfaction level of students on technical education at the polytechnic institutes	The target level is **[4.5 on 5-point scale]** for each pilot polytechnic institute. *By the end of the 1st period	DPI: **[4.2]** DMPI **[4.5]**	The target level is **[4.5 on 5-point scale]** for each pilot polytechnic institute. *By the end of the 2nd period (including the

			pilot institute outside Dhaka)
Indicator 2. Percentage of the graduates employed among those who wanted to get a job	The target percentage is **[over 50% after one year of graduation]** for each pilot polytechnic institute. *By the end of the 1st period	DPI: **[23%]** DMPI: **[16%]**	The target percentage will be revised in the 2nd period of the project. (Employment rate will be collected after 1-2 years from graduation)
Indicator 3. Satisfaction level of companies on the performance of the graduates	The target satisfaction level is **[more than 60%]** for each pilot polytechnic institute. *By the end of the 1st period	DPI: **[89%]** DMPI: **[100%]**	The target satisfaction level is **[more than 60%]** for each pilot polytechnic institute. *By the end of the 2nd period (including the pilot institute outside Dhaka)

Details of revision:

・For Indicators 1 to 3, the target values until the completion of the 1st period were changed to the target values until the completion of the 2nd period. In addition, one pilot institute outside Dhaka City was included.

・For Indicator 2, similar follow-up surveys were conducted by other donors, such as the World Bank (WB) and the EU, which examined the employment status of targeted polytechnic graduates in the past two years. From the perspective of consistency and comparison with the survey results, this project also acquired the employment status data for graduates within the past two years.

3. Output 1

PDM Indicator	Target Value (1st version)	Achievement as of the end of the 1st period	Target Value (Revised version)
Indicator 1. A working group established for improving technical education at each pilot polytechnic institute in Dhaka City	Establishment of a working group at DPI and DMPI	Working groups were established in DPI and DMPI and the target was achieved.	No revision
Indicator 2. An action plan to improve technical education at each pilot polytechnic institute in Dhaka City	Development of an action plan at DPI and DMPI	An Action Plan for the first period of the project was developed together with DPI and DMPI.	No revision

Details of revision:

・There is no revision of the target value, but it is necessary to produce an action plan for the 2nd period for Indicator 2.

4. Output 2

PDM Indicator	Target Value (1st version)	Achievement as of the end of the 1st period	Target Value (Revised version)
Indicator 1. Number of	Target number of	Number of monitoring:	Target number of

monitoring on the progress of the action plan	monitoring is **[9]** by May 2022 *By the end of the 1st period	**[9]**	monitoring is **[17]** by February 2024 *By the end of the 2nd period
Indicator 2. Number of faculty members who participated in developing a guideline for improving technical education	Target number is **[25]**, since guidelines should be developed through discussions from various viewpoints and making trials. *By the end of the 1st period	Number of teachers who participated in the development of technical education improvement guideline: **[32]**	Target number is **[25]**, since guidelines should be developed through discussions from various viewpoints and making trials. *By the end of the 2nd period
Indicator 3. Number of hands-on manuals verified	Minimum target number is **[27]** and verification will be conducted based on the skill list of each model subject. *By the end of the 1st period	Number of developed hands-on manuals: **[27]**	Minimum target number is **[43]** and verification will be conducted based on the skill list of each model subject. *By the end of the 2nd period
Indicator 4. A guideline for improving technical education verified	**[1]** guideline will be made by DPI and DMPI. *By the end of the 1st period	Number of developed guideline: **[1]**	**[1]** guideline will be made by DPI and DMPI. *By the end of the 2nd period
Indicator 5. Number of training events given by TTTC for polytechnic institutes	After completion of the guideline, at least **[1]** training program to disseminate the guideline will be held for principals and HoDs of other polytechnic institutes in Bangladesh. *By the end of the 1st period	Number of dissemination workshop: **[1]**	After completion of the guideline, at least **[2]** training program to disseminate the guideline will be held for principals and HoDs of other polytechnic institutes in Bangladesh. *By the end of the 2nd period

Details of revision:

- For Indicators 1 to 3, the target values until the completion of the 1st period were changed to the target values until the completion of the 2nd period.
- For Indicator 1, a total of 17 times (1st period: 9; 2nd period: 8) were assumed.
- For Indicator 3, 43 manuals (1st period: 27; and 2nd period: 16) are assumed.
- For Indicator 5, a total of two times (1st period: 1; and 2nd period: 1) were assumed.

5. Output 3

PDM Indicator	Target Value (1st version)	Target Value (Revised version)
Indicator 1. A working group established for improving technical education at a pilot polytechnic institute outside Dhaka City	Establishment of a working group at Cox's Bazar Polytechnic Institute	No revision
Indicator 2. Number of faculty	N/A	The target value will be set

members who participated in developing an action plan for improving technical education		after the start of the 2nd period
Indicator 3. Number of monitoring on the progress of the action plan	N/A	The target value will be set after the start of the 2nd period
Indicator 4. Number of hands-on manuals developed	N/A	The target value will be set after the start of the 2nd period
Indicator 5. Number of training events given by TTTC for a pilot polytechnic institute outside Dhaka City	N/A	The target value will be set after the start of the 2nd period

Details of revision:

- The target values of Output 3 will be set after the start of the 2nd period, except for the establishment of the Working Group of Indicator 1.

6. Output 4

PDM Indicator	Target Value (1st version)	Achievement as of the end of the 1st period	Target Value (Revised version)
Indicator 1. Number of activities implemented by the job placement cells	The target number is **[16]** at each pilot institute, including lectures/seminars, internship preparation and feedback sessions, questionnaire survey of current students, graduates, and companies which hired the graduates, etc. *By the end of the 1st period	Number of implemented activities DPI: **[14],** DMPI: **[13]**	The target number is **[22]** at DPI and DMPI including lectures/seminars, internship preparation and feedback sessions, questionnaire survey of current students, graduates, and companies which hired the graduates, etc. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.
Indicator 2. Number of job matching by utilizing information of companies	The target number is **[25]** at each pilot institute *By the end of the 1st period	Number of job matching DPI: **[2],** DMPI: **[1]**	The target number is **[10]** at each pilot institute *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.
Indicator 3. Number of events with companies, such as training, internship, site tour and	The target number of events is **[6]** at each pilot institute including internship and job fair;	Number of implemented events DPI: **[4],** DMPI: **[4]**	The target number of events is **[8]** at DPI and DMPI including internship and job

number of students participated	the target number of students who have participated in these events is **[2700]** at DPI and **[660]** at DMPI *By the end of the 1st period		fair; the target number of students who have participated in these events is **[3909]** at DPI, **[968]** at DMPI. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.
Indicator 4. Number of students who had career counselling	The target number is **[1350]** at DPI and **[330]** at DMPI *By the end of the 1st period	DPI: **[registered 761]** DMPI: **[registered 105]**	The target number is **[2283]** at DPI, **[315]** at DMPI. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.
Indicator 5. Number of companies that collaborated with the pilot polytechnic institutes	The target number is **[50]** at each pilot institute. *By the end of the 1st period	DPI: **[87]** DMPI: **[68]**	The target number is **[80]** at DPI and DMPI. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.
Indicator 6. Satisfaction level of students regarding the job placement conducted by the pilot polytechnic institutes	Target level is **[85%]** for each pilot polytechnic institute. *By the end of the 1st period	DPI: **[77%]** DMPI: **[91%]**	Target level is **[85%]** for each pilot polytechnic institute. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.

Details of revision:

- For Indicators 1–6, the target values until the completion of the 1st period were changed to the target values until the completion of the 2nd period.
- The target values for a pilot polytechnic institute outside Dhaka City will be set after the start of the 2nd period.
- For Indicator 2, the target value will be revised in the 2nd period through re-evaluation of the influence of the COVID-19 pandemic and method of counting the achieved value.

1.4 Target Area

Dhaka city (1st and 2nd Period) and outside Dhaka city (Cox's Bazar from the 2nd Period)

1.5 Implementation Agencies

Main Counterpart Agency:	Directorate of Technical Education, Technical and Madrasah Education Division, Ministry of Education
Other Counterpart Agency:	Dhaka Polytechnic Institute (DPI), Dhaka Mohila Polytechnic Institute (DMPI), Technical Teachers Training College (TTTC)
Japanese Implementation Agency:	Japan International Cooperation Agency (JICA)

2 Contents of the Activities

2.1 Outline of the Project Activities in the 1st Period

This project supported DPI, DMPI, and TTTC, and aimed to improve the technical education and strengthen industry-academia collaboration and employment support in the electrical, electronics, mechanical, and computer fields. In the 1st period, the management system of the project was established by the JCC and working groups. To improve technical education, hands-on manuals for practical training, training of teachers (TOT), verification of the effectiveness of improved technical education, and development of guidelines for improving technical education were implemented. However, owing to COVID-19, the pilot institutes were closed and the Japanese experts' travel to Bangladesh was also restricted. Under the situation, the project implementation plan was modified, through which the TOT was switched to remote training from Japan, and the effectiveness of technical education improvement was verified through the evaluation of hands-on manuals developed by local teachers. In addition, the training in Japan was planned to be held once a year for a total of three times within the 1st period. However, it was difficult for local teachers to travel to Japan because of COVID-19 since 2020, so it was carried out only once in the 1st year. For job placement support activities, a network with Japanese companies that were operating in Bangladesh was developed in addition to local companies, through which internships of DPI students were accepted by Japanese companies, and online industry-academia collaboration events in which Japanese companies participated were held. The following is an overview of the activities of each output:

For Output 1, working groups were established in DPI and DMPI; their roles, responsibilities, and membership were decided, and a total of six working group meetings were held at each institute. From the 1st to the 4th meeting, face-to-face meetings were held at each institute, and from the 5th onwards, online meetings were held due to restrictions on Japanese experts' overseas travel and gatherings due to COVID-19. In addition, model subjects for each target technology were selected through discussions between KOSEN professors and local teachers. Moreover, an action plan for improving technical education was developed jointly by DPI and DMPI, with the established working group members playing a central role.

For Output 2, hands-on manuals for practical training were developed for the model subjects selected in Output 1, and face-to-face and online TOT were conducted by KOSEN professors for DPI, DMPI, and TTTC teachers. In the original plan, local teachers who took the TOT were supposed to provide improved technical education to students at each institute, but the educational institutes all over Bangladesh, including pilot institutes, were closed because of COVID-19 from March 2020 to September 2021. Practical training was conducted only for some students in mechanical technology. Draft hands-on manuals for practical training developed by local teachers were used to verify the effectiveness of the technical education improvement. In addition, technical education improvement guidelines were developed in the form of instruction manuals for the development of hands-on manuals for practical training by local teachers. The draft hands-on manuals were developed by local teachers based on it. TTTC faculty members played a central role in developing technical education improvement guidelines, and a workshop was held online to disseminate them to polytechnic institutes other than the DPI and DMPI.

For Output 3, one pilot polytechnic institute outside Dhaka was selected through discussions with DTE. In the 3rd JCC meeting, discussion was made with DTE on targeting Cox's Bazar Polytechnic Institute from the 2nd period of the project as well as target technologies and subjects. Finally, it was formally agreed in the 4th JCC meeting that Cox’s Bazar Polytechnic Institute would be the 3rd pilot polytechnic institute of project from the 2nd period. Other activities of Output 3 are scheduled to start in the 2nd period.

For Output 4, industry-academia collaboration and job placement support activities were conducted by targeting DPI and DMPI. First, the principals of DPI and DMPI appointed teachers in charge of job placement support at each institute, and a job placement support action plan for each was developed through discussions with teachers in charge of job placement support and working group meetings. The actual job placement support activities began by collecting information on local companies, including organizing information of companies that have already cooperated with each institute, and collecting information on Japanese companies operating in Bangladesh, which also contributes to building a network with them. Next, students’ internships were coordinated with local and Japanese companies, as well as job placement support seminars for students. For career guidance, in cooperation with ILO experts, trainings for job placement supported teachers and workshops for students regarding career guidance and counseling were held. For job matching activities, DPI and DMPI’s Facebook pages for job placement support were created to distribute information such as that of job vacancies. Furthermore, an “Online Industry-academia Collaboration Event Between Japanese Companies and Polytechnic Institutes 2022” was held, in cooperation with the Japanese Embassy, Japanese Commerce

& Industry Association in Dhaka (JCIAD), JETRO Dhaka, and several Japanese companies. This event was held as part of the 50th anniversary of the establishment of diplomatic relations between Japan and Bangladesh.

2.2 Activities for Output 1

Activity 1-1 Each pilot polytechnic institute in Dhaka City defines members, roles and responsibilities of the working group for improving technical education

In consultation with the Principals, Vice-Principals, and HoDs at Dhaka Polytechnic Institute (DPI), Dhaka Mohila Polytechnic Institute (DMPI), and Technical Teachers Training College (TTTC), the members of the working group were selected at each pilot institute. Their roles and responsibilities were explained and a clear understanding was shared among them. The members were officially appointed by each principal and instructed to participate in the Working Group Kickoff Meeting on July 2, 2019. Based on the suggestion by the DTE and each principal, one person in charge of each of the Japanese Commerce and Industry Association in Dhaka (JCIAD) and the Dhaka Chamber of Commerce and Industry (DCCI) were selected and included as members. The participation in each process of project planning, implementation, and monitoring was clarified. Table 2 is a list of Working Group members.

Table 2. Working Group members of each pilot institute

Dhaka Polytechnic Institute	Dhaka Mohila Polytechnic Institute
• Principal • Vice Principal • Assistant Director of DTE (No.5) • HoDs of Electrical/Electronics, Mechanical and Computer Technology • Instructors of Electrical/Electronics, Mechanical and Computer Technology • Person in charge of job placement service • HoDs of Mechanical and Electrical, Electronics Engineering at TTTC • Assistant Professor and lecturers of Mechanical and Electrical, Electronics Engineering at TTTC • Japanese Commerce and Industry Association in Dhaka • Dhaka Chamber of Commerce and	• Principal • Vice Principal • Assistant Director of DTE (No.4) • HoDs of Electronics and Computer Technology • Instructors of Electronics and Computer Technology • Person in charge of job placement service • HoD of Electrical, Electronics Engineering at TTTC • Assistant Professor and lecturers of Electrical, Electronics Engineering at TTTC • Japanese Commerce and Industry Association in Dhaka • Dhaka Chamber of Commerce and

Industry • JICA Experts (including KOSEN Professors)	Industry • JICA Experts (including KOSEN Professors)

Activity 1-2 The pilot polytechnic institutes in Dhaka City select model subjects for improving technical education.

After discussions with the principals, vice-principals, and HODs at DPI, DMPI, and TTTC, the KOSEN professors confirmed the facility equipment of each technology, met with teachers, and observed the classroom and examination. Through these observations and consideration of the needs of each pilot institution, TTTC, and industry, the selected model subjects were agreed upon based on the KOSEN professors' recommendations. At the working group kick-off meeting on July 2, 2019, discussions on the selection of model subjects were held with members of the working groups of both pilot institutes. Subsequently, each model subject was approved by DTE. Table 3 lists the selected model subjects.

Table 3. Selected Model Subjects

Technology	Model Subject
Electrical	Alternating Current Machines I, II
Electronics	Microcontroller and Embedded System
Mechanical	Hydraulics and Hydraulic Machineries
Computer	Programing Essentials, Programing in Java, Web Design

Activity 1-3 The working group develops an action plan to improve technical education.

At the working-group kick-off meeting, the roles and responsibilities of the working group, confirmation of PDM and PO, selection of model subjects, training schedule, and job placement support activities were explained and discussed. All members recognized the importance of creating an action plan to conduct the project activities, and on the formation of the action plan, the participants agreed to prepare a draft during training in Japan in November 2019. On November 9, at the first training session in Japan, all participants of Groups 1 and 2 gathered to be guided on how to make an action plan, and discussed its outline. In addition, a workshop on action plan making was held for Group 2, where practitioners at the institutes were invited on November 18 and 19 in Japan. Since the school system for both DPI and DMPI is defined by the BTEB, creating a common action plan for each institute was decided. The draft version prepared during the Japan training was finalized and agreed upon at the working group meeting held on December 3 and 4 in Dhaka. On January 22, DPI and DMPI representatives and local consultants visited the DTE and explained the process and contents of the action plan to DTE's Director of the Planning Department. DTE made a final confirmation and approval to proceed with the activities based on the action plan. See attachment 1-2 for the final action plan.

2.3 Activities for Output 2

Activity 2-1 Based on the action plan, educational materials such as hands-on manuals of practical lessons for the selected subjects are developed.

In the TOT for teachers at the pilot polytechnic institutes by KOSEN professors, the following hands-on manuals of practical training were developed, based on the content of each TOT.

Table 4. Hands-on manuals for practical training developed by KOSEN professors

Technology	Number of manuals
Electrical and Electronics Technology	5
Mechanical Technology	4
Computer Technology	2

Based on the guidelines for improving technical education in Activities 2-5, each technology assigned TOT participants to four teams of four members per team. After selecting topics for the hands-on manuals by team, hands-on manuals were developed. Based on feedback sessions and e-mail feedback from KOSEN professors, the members of the pilot polytechnic institute finalized hands-on manuals after several revisions. Table 5 presents the number of hands-on manuals developed and the topics selected.

Table 5. Hands-on manuals for practical training developed by local teachers

Technology	Number of hands-on manuals	Topic
Electrical	4	• Start a three-phase induction motor by star delta starter by PLC. • Observe and determine the transformation ratio of a single phase transformer. • Perform the short circuit test of a single phase transformer (AC MC-1). • Perform V-V and T-T connection of transformer banking.
Electronics	4	• Develop and test a program for interfacing stepper motor using Arduino Uno. • Develop and test a program for flashing LEDs by using Arduino UNO. • Develop and test a program for Interfacing DC Motor. • Develop and test a program for displaying 0 to 9 on 7-Segment display.
Mechanical	4	• Determine CC, CV, and Cd by orifice apparatus equipped with hydraulic test bench. • Determine the loss of head due to sudden enlargement of pipe by the manometer. • Determine the moment force of a jet of water striking targets of different shape with the impact of jet apparatus.

		• Calibrate a bourdon tube pressure gauge with a dead weight gauge.
Computer	4	• Program using Functions (Programming Essentials) • Write and execute Java programs using arrays and control flow statements. (Programming in Java) • Programs using operators (Programming Essentials) • Programs using Looping Statements (Programming Essentials)

Activity 2-2 Faculty members of the pilot polytechnic institutes together with TTTC participate in training for improving technical education.

The TOTs for teachers at the pilot polytechnic institutes by KOSEN professors were conducted by each department on September 11 and 12, 2019, on a trial basis. The initial TOTs were conducted at the National Institute of Technology, Tsuruoka College, from November 13 to 15, 2019, during the Japan training. The 2nd set of TOTs were scheduled to be held in March 2020. However, the COVID-19 pandemic made it difficult for project members to travel to Bangladesh; therefore, the TOTs were conducted remotely using online tools. In addition, regarding the hands-on manuals that were developed by the local teachers of each technology in Activity 2-1, remote TOTs were conducted in March 2022. In this TOT, the teachers at the polytechnic institutes conducted experiments based on hands-on manuals, and the KOSEN professors provided advice in anticipation of the experiments implemented by students in the lessons under the instruction of the local teachers.

Table 6 shows the results of TOT in each technology.

Table 6. Results of TOT implementation

Technology	TOT	Date of implementation	Number of participants (Each date)
Electrical	Trial TOT	Sep. 11 and 12, 2019	10
	1st TOT (Training in Japan)	Nov. 13-15, 2019	4
	2nd TOT (Remote)	Dec. 23, 2020, Jan. 21, 2021, Feb. 25, 2021, March 18, 2021 Sep. 1, 2021, Oct. 6, 2021 Oct. 27, 2021	13
	TOT based on the hands on manuals developed by local teachers (Remote)	Oct. 3, 2022	13
Electronics	Trial TOT	Sep. 11 and 12, 2019	12
	1st TOT (Training in Japan)	Nov. 13-15, 2019	4
	2nd TOT (Remote)	Aug. 31, Oct. 11, and Nov. 1, 2021	12
	3rd TOT (Remote)	Mar. 8, 22, 28, 2022	12

	TOT based on the hands on manuals developed by local teachers (Remote)	Mar.29, 2022	12
Mechanical	Trial TOT	Sep. 11-12, 2019	13
	1st TOT (Training in Japan)	Nov. 13-15, 2019	3
	2nd TOT (Remote)	Aug. 17, 19, and 24, 2020	14
	3rd TOT (Remote)	Dec. 21, 23, and 24, 2020	13
	4th TOT (Remote)	Sep. 16 and 22, and Oct. 18, 2021	13
	TOT based on the hands on manuals developed by local teachers (Remote)	March 7-8, 2022	13
Computer	Trial TOT	Sep. 11-12, 2019	11
	1st TOT (Training in Japan)	Nov. 13-15, 2019	3
	2nd TOT (Remote)	Aug. 25 and 27, and Sep. 1 and 3, 2020	11
	3rd TOT (Remote)	Jan. 21 and 25, and Feb. 1 and 2, 2021	12
	4th TOT (Remote)	Oct. 26 and Nov. 4, 2021	12
	TOT based on the hands on manuals developed by local teachers (Remote)	Mar., 2022	12

Activity 2-3 Faculty members of the selected subjects conduct improved technical education.

In "Hydraulics and Hydromechanics," one of the model subjects in the Mechanical Technology, the HoD, and other teachers in DPI conducted the same experiments for DPI students by using what they learned in TOT by the KOSEN professor.

Activity 2-4 The Pilot polytechnic institutes verify the effectiveness of improved technical education.

A workshop was held at the TTTC on December 15, 2021 for all four technologies to prepare a hands-on manual. The TOT participants were divided into four teams of four members for each technology. Each team prepared hands-on manuals and participated in a feedback session to obtain comments from KOSEN professors. The hands-on manuals were revised by the teachers based on feedback from the KOSEN professors. Regarding the revised hands-on manuals, technology-related feedback sessions were held by KOSEN professors for mechanical technology on January 19, 2022, three teams from computer technology on January 27, 2022, one team from computer technology on February 1, 2022, electrical technology on February 24, 2022, and electronics technology on March 7, 2022.

To evaluate the hands-on manuals developed by local teachers, an evaluation table for hands-on manuals was prepared together with KOSEN professors, based on the points described in the hands-on manuals that are mentioned in the Guidelines for the Improvement of Technical Education. Table 7 shows the results of evaluations by the KOSEN professors in charge of each technology on the hands-on manuals developed by 16 teams based on the evaluation items in the evaluation table. As a result of the evaluation, 15 out of 16 hands-on manuals for practical training met the achievement goals which indicated that the effectiveness of technical education improvement was verified.

Table 7. Evaluation results of hands-on manuals developed by the faculty members

Evaluation Item		Evaluation Result															
		Electrical Team				Electronics Team				Mechanical Team				Computer Team			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Achievement objectives are described using the action verbs of the students	O	O	O	O	O	O	O	O	O	O	X	X	O	X	O	O
2	Experimental content can be compared or verified with theory	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
3	Detailed description of experimental methods and use of equipment is provided	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
4	Experimental procedures are described	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
5	A table, blank or formatted, is provided to describe the results	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	X
6	Methods or procedures for analyzing and discussing the results are described	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7	The structure of the manual is written in a way that is in line with the actual procedure for students to carry out the experiment (e.g. Precaution at the end of the manual is no good)	X	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O
8	The references referred to are described at the end of the manual	O	O	O	X	O	X	X	O	O	O	O	O	O	O	O	O
9*	The manual is written in an easy-to-read format (e.g. the text is written in an easy-to-read size, there is an attempt to identify important points, and the information is structured hierarchically)	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲		╲	╲
10*	The manual is written in an easy-to-understand manner (e.g. is the content appropriate for the level of the reader (student)?	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲	╲		╲	╲
Result of verification(The achievement target is 75% (6 out of 8 items) achieved)		**O**	**O**	**O**	**X**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**

*9 was not included in the technical education improvement guideline, so it was not evaluated this time and will be included in the evaluation from the next time.

*10 was not evaluated this time because the KOSEN professors could not actually see the practical training to students on site and could not judge the level of the reader (student).

Activity 2-5 Based on results of the verification, the pilot polytechnic institutes update the educational materials and formulate a guideline for improving technical education.

A professor from the headquarters of the National Institute of Technology has developed the first draft of a guideline for improving technical education for the preparation of hands-on manuals based on KOSEN's practical training manuals. After discussions with the project members, including other KOSEN professors, opinions were exchanged with teachers at the pilot polytechnic institutes on the guidelines through working group meetings. In addition, on August 3, 2021, guidance was provided to TOT participants on the draft guidelines to improve technical education and preparation of hands-on manuals. At that time, there were no comments on the revisions to the content of the draft guidelines; hence, they were finalized by reflecting the feedback of the participants as the teams from each technology proceeded with the preparation of the hands-on manuals.

The guidelines on improving technical education are also accompanied by hands-on manuals that were developed by KOSEN professors.

Activity 2-6 The guideline is shared with other polytechnic institutes through TTTC.

An online dissemination workshop based on the guideline for improving technical education developed in Activities 2-5 was held on April 21. In the workshop, contents of the guideline were explained and the hands-on manuals developed by the faculty members of TTTC, DPI, and DMPI based on the guideline were introduced to other public polytechnic institutes participated from all over the country. In total about 110 people participated in the workshop including DTE, BTEB, JICA, TTTC, DPI, DMPI, principals and faculty members from other 35 public polytechnic institutes, and staff of the World Bank. The guideline for the improvement of technical education that were developed in the 1st period of the project will be updated as necessary in the 2nd period and continue to be disseminated to other polytechnic institutes.

2.4 Activities for Output 3

In the 1st period of the project, one pilot polytechnic institute outside Dhaka City was selected as the target from the 2nd period. Regarding the pilot institute outside Dhaka city, Cox's Bazar Polytechnic Institute was proposed as a candidate, and discussions with DTE have been held since August 2019. In the 3rd JCC meeting held in November 2021, Cox's Bazar Polytechnic Institute was selected as the target institute. It only has computer technology among the electrical, electronics, mechanical, and computer technologies that are the targets of the project. However, in addition to computer technology, civil, refrigeration, and air conditioning (RAC) technologies, which are covered by Cox's Bazar Polytechnic Institute, are subject to the model subjects of the project. Therefore, the project planned to implement support activities, such as TOT, mainly for those subjects in the 2nd period. Table 8 below shows the model subjects selected at DPI and DMPI and related subjects at Cox's Bazar Polytechnic Institute.

Table 8. Related Subjects at Cox's Bazar Polytechnic Institute

DPI, DMPI		Cox's Bazar Polytechnic Institute	
Technology	Model Subjects	Related Subjects	Technology
Computer	• Programming Essentials • Programming in Java • Web Design	• Programming Essentials • Programming in Java • Web Design	Computer
Mechanical	• Hydraulics & Hydraulic	• Hydraulics	Civil

	Machineries	• Fluid Mechanics and Machineries	RAC
Electronics	• Microcontroller & Embedded System	• Microcontroller Application	Computer
Electrical	• Alternating Current Machines 1 • Alternating Current Machines 2	• Electrical Machines in RAC	RAC

In addition, as a result of a site visit to Cox's Bazar Polytechnic Institute on November 3, 2021, the following issues were observed.

(1) Issues related to practical training

Cox's Bazar Polytechnic Institute was established in 2004, after which the World Bank's STEP provided equipment for computer technology. However, the equipment of other technologies has hardly been updated, and it is aging. In addition, there are problems such as not being able to carry out all the practical training items on the syllabus due to lack of equipment. The issues in each technology are as follows.

- In the computer technology, only TOT is required because there are PCs supported by the STEP. Also, PLC (Programmable Logic Controller) training equipment was introduced in STEP, but it was not well utilized because of the lack of knowledge. There is a problem that only one or two oscilloscopes are in operation.
- In Civil and RAC technologies, there is only the equipment introduced when the institute was established in 2004, and it is not used because the software is outdated.
- There is only one faculty member in the electrical field in RAC technology, and that faculty member is teaching electrical classes of all the technologies.

(2) Issues related to job placement support

- There is no official job placement support office, and activities are carried out in the temporary room.
- Previously, the ILO project had full-time staff, but since the project ended in 2018, there have been no full-time staff.
- Job placement support activities such as job placement seminars are not carried out, and jobs are introduced to students through personal connections of teachers.

2.5 Activities for Output 4

Activity 4-1. The pilot polytechnic institutes in Dhaka City assign faculty members and develop action plans for promoting collaboration with industry.

(1) Assignment of teachers in charge of job placement support

At the end of June 2019, the project team had discussions with the principals, vice principals, and department heads of DPI and DMPI, and explained the roles and responsibilities of the teachers in charge of industry-academia collaboration at each pilot institute. In response, the principal of each institute assigned one teacher in charge of job placement support to promote industry-academia collaboration. The teacher-in-charge became a member of the working group.

(2) Development of an action plan for job placement support

The project team discussed the development of the action plan with the job placement support teachers assigned at each pilot institute. A draft action plan was presented at the working group meeting held at DPI and DMPI in September 2019, in which discussions were conducted with the participants. The revised action plan based on the results of the discussion was shared at the working group meetings held at each pilot institute in December 2019 and agreed to be the final version. Subsequently, in January 2020, the contents of the action plan were explained to the DTE, and they were approved. The developed job placement support action plan is shown in Attachments 1-3.

Activity 4-2. The job placement cells at the pilot polytechnic institutes in Dhaka City collect information on private companies including job offer, employment and performance of the graduates.

(1) Collecting information from private companies

During the baseline survey conducted between April and July, 2019, the project team visited the Federation of Bangladesh Chambers of Commerce and Industries (FBCCI) and the Dhaka Chamber of Commerce & Industry (DCCI), which are local industrial organizations in Bangladesh. In March 2020 and April 2022, and the project team and job placement cells gathered information on the current state of industry in Bangladesh and the human resource needs of companies. In addition, a survey was conducted on the companies that signed an MoU for industry-academia collaboration, and local companies and organizations that were accepting internship students at each pilot institute. A list of partner companies was created based on the survey. As of April 2022, DPI had 60 companies (including organizations) in four technologies, and DMPI had a record of cooperation with 35 companies in two technologies. Tables 9 and 10 list the partner companies for the DPI and DMPI, respectively. As a result of the survey, it was found that DPI and DMPI had a track record of collaborating with many companies mainly through internships. However, except for companies such as Samsung, which had a "Samsung Lab" in DPI and DMPI, there was little promotion of industry-academia collaboration in terms of technical education.

Table 9. List of DPI partner companies in April 2022

No.	Name of Company/Organization	Technology	Relationship with Pilot Institute		Number of Accepted Interns	
					In 2020	In 2021
1	System Engineers Limited	Electrical	MoU			
2	Rainbow Automation	Electrical		Internship	121	84
3	Matlab Technical & Computer Training Institute	Electrical		Internship	74	

4	Adex Engineering Ltd.	Electrical		Internship	6	
5	Bangladesh Industrial Technical Assistance Centre- BITAC	Electrical		Internship	6	10
6	Brac Institute of Skill Development	Electrical		Internship	7	
7	Reverie Power & Automation Engineering Ltd	Electrical		Internship	2	
8	Incepta Pharmaceuticals Limited	Electrical		Internship	2	
9	Bachar Engineering Ltd.	Electrical		Internship	3	
10	Royal Footwear Ltd.	Electrical		Internship	1	
11	Bangladesh Rural Electrification Board	Electrical		Internship		11
12	Gazipur Automation Industries Ltd.	Electrical		Internship		226
13	Unique Automation Industries Ltd.	Electrical		Internship		1
14	National Tube	Electrical/Mechanical		Internship	0/25	3/42
15	Energy Pac	Electrical/Electronics		Internship		18/5
16	Desh Automation and Development Engineering Institute	Electrical/Electronics		Internship	0/7	126/5
-	Other Companies	Electrical		Internship		16
17	Samsung India Electronics Limited	Electronics	MoU			
18	Kumrul HR Division Ltd.	Electronics		Internship	42	
19	Fabotronix	Electronics		Internship	8	14
20	Bangla CAT	Electronics		Internship	1	
21	Linnex Technologies Ltd.	Electronics		Internship	3	
22	Fair Solution Ltd.	Electronics		Internship	18	5
23	HighTech, Humidis	Electronics		Internship	6	3
24	IMBPVSI	Electronics		Internship	2	
25	Mohsina Technical Solution	Electronics		Internship	22	
26	Walton Group (Corporate office)	Electronics		Internship	10	2
27	Tech Team Engineering Ltd.	Electronics		Internship	1	
28	M. Power Engineering	Electronics		Internship	5	10
29	Transcom Electronics Ltd.	Electronics		Internship	14	
30	Smart Technologies (BD) Ltd.	Electronics		Internship	5	
31	MTS Training Institute	Electronics		Internship		24
32	Rainbow Automation	Electronics		Internship		9
33	Medicom International Ltd.	Electronics		Internship		4
34	BRAC Institute of Skills Development	Electronics		Internship		16
35	Tech Lab Bangladesh	Electronics		Internship		7
36	M.TECH	Electronics		Internship		22
37	Kornafuli Media Ltd.	Electronics		Internship		1
38	NOVA Electronics Co.	Electronics		Internship		4
39	Peak Automation	Electronics		Internship		24
40	1000 Fix Limited	Electronics		Internship		5
41	Akiz Bakers Ltd	Electronics		Internship		5
42	Radiant Communication Ltd	Electronics		Internship		1
43	Inspore Engineering	Mechanical	MoU			
44	BITAC	Mechanical	MoU	Internship	109	191
45	Machine Tools Factory	Mechanical		Internship	50	50
46	Water Development Board	Mechanical		Internship	35	30
47	T & S Buttons BD Ltd	Mechanical		Internship	1	
48	Roads & Highway	Mechanical		Internship		2
49	Summit	Mechanical		Internship		3
50	Rangs Industries Ltd	Mechanical		Internship		2
51	Creative IT	Computer	MoU			221
52	Ammra Netwarks Limited	Computer	MoU			
53	ADN Edu Services Limited	Computer	MoU			
54	UY Lab	Computer	MoU			
55	Kingfisher IT	Computer	MoU			
56	Graph –ai	Computer	MoU			
57	Global IT & Language Institute Limited	Computer	MoU	Internship	30	

58	IT Bangladesh	Computer	MoU	Internship	59	
59	Naztech Inc. Ltd.	Computer		Internship	62	
60	Supershine Skill Development Center	Computer		Internship	11	

Table 10. List of DMPI partner companies in April 2022

No.	Name of Company/Organization	Technology	Relationship with Pilot Institute		Number of Accepted Interns	
					In 2020	In 2021
1	Multipurpose Engineering & Industrial Automation	Electronics	MoU	Internship	18	6
2	Mohsina Technical Solution	Electronics	MoU	Internship	15	
3	Pico Technology	Electronics	MoU	Internship	8	13
4	A Haque Electronics	Electronics	MoU			
5	MyOne	Electronics	MoU	Internship	8	6
6	FaboTronix	Electronics	MoU			
7	Rainbow Automation	Electronics	MoU	Internship	14	17
8	Bangladesh Television	Electronics		Internship	1	
9	Symphony	Electronics		Internship	24	9
10	North Bengal Engineering Institute	Electronics		Internship		6
11	Rangs Industries Ltd	Electronics		Internship		2
12	Nissan Electro. Co	Electronics		Internship		4
13	Peak Automation	Electronics		Internship		6
14	SR Institute of Design	Computer	MoU	Internship	2	
15	IT Bangladesh	Computer	MoU	Internship	9	
16	BD Task Software Limited	Computer	MoU	Internship	19	19
17	Creative IT Institute	Computer	MoU	Internship	10	31
18	Inflexion Point Bd Limited	Computer	MoU			
19	UY Lab	Computer	MoU			
20	Global IT	Computer	MoU	Internship	3	
21	Datatrix Soft	Computer	MoU			
22	Open IT Limted	Computer	MoU			
23	RAWN	Computer	MoU			
24	People Tech	Computer	MoU			
25	Cad Zone	Computer		Internship	5	3
26	Anira International Ltd.	Computer		Internship	2	
27	Mirpur Area	Computer		Internship	7	
28	Logic Engineering & Automation	Computer		Internship	13	
29	AMM Technology	Computer		Internship		2
30	Kapashia Technical School & Computer Training	Computer		Internship		1
31	ISIT	Computer		Internship		10
32	Project Solution Engineering & Consultancy Ltd	Computer		Internship		26
33	European IT BD	Computer		Internship		15
34	CTIT Technical Institute	Computer		Internship		2
35	Auto CAD Training Institute	Computer		Internship		2

With respect to Japanese companies operating in Bangladesh, the project team interviewed JCIAD and JETRO Dhaka, industrial organizations related to Japanese companies, and visited or conducted online interviews with 16 Japanese companies and organizations shown in Table 11. Through the interviews, information on human resource needs and the possibility of collaboration with projects was collected. As a result, many companies tended to require the technical staff to have basic skills such as communication skills, diligence, honesty, and self-motivation rather than advanced technical knowledge and skills. However, some companies were promoting mechanization and automation of factories due to increasing labor costs, and it became clear that such companies had a need for human resources with skills such as process control and equipment maintenance. As the need for factory automation increases due to the COVID-19 pandemic, the need for such human resources is expected to increase in the future.

Table 11. List of interviewed Japanese companies operating in Bangladesh

No.	Company/Organization	Related Industry
1	A	IT
2	B	RMG
3	C	RMG
4	D	Inspection
5	E	Electrical work
6	F	Education
7	G	RMG
8	H	Energy management
9	I	RMG
10	J	Food
11	K	IT
12	L	IT
13	M	IT
14	N	Printing
15	O	Training
16	P	Pharmaceuticals

(2) Questionnaire survey for students and companies

Questionnaire survey for final semester students before graduation

Questionnaire survey for eight semester students which is the final semester of a four-year diploma course, conducted before graduation. In the survey, the preferred career path after graduation and level of satisfaction with job placement support were investigated at each pilot institute. The results of the survey conducted for the final semesters of 2019 and 2021 are described below. A survey of final semester students in 2022 was conducted in April 2022 during the final exams. Since educational institutions including pilot institutes were closed from March 2020 to September 2021 because of COVID-19, the next set of graduates after the 2019 was that of the year of 2021.

1. Pre-Graduation Questionnaire Survey Results in 2019

The number of respondents to the pre-graduation questionnaire survey at DPI and DMPI in 2019 are shown in Tables 12 and 13, respectively. The survey was conducted in August 2019, when the final exams before graduation were conducted, targeting all 8th semester students of the target technologies.

Table 12. Number of Pre-Graduation Survey Respondents (DPI) in 2019

Technology	Male	Female	Total
Electrical	160 (87%)	24 (13%)	184
Electronics	89 (84%)	17 (16%)	106
Mechanical	159 (85%)	27 (15%)	186
Computer	71 (81%)	17 (19%)	88
Total	479 (85%)	85 (15%)	564

Table 13. Number of Pre-Graduation Survey Respondents (DMPI) in 2019

Technology	Total
Electronics	69
Computer	91
Total	160

The DPI and DMPI survey results are presented in Figures 1 and 2, respectively. Regarding their preferred career paths after graduation, it was revealed that 59% of DPI students and 65% of DMPI students wanted to get a job, and most of the other students wanted to pursue higher education. Regarding the level of satisfaction with job placement support, the total of “very satisfied” (23%) and “satisfied” (46%) was 69% at DPI, and the total of “very satisfied” (21%) and “satisfied” (62%) was 83% at DMPI. The respondents were generally satisfied.

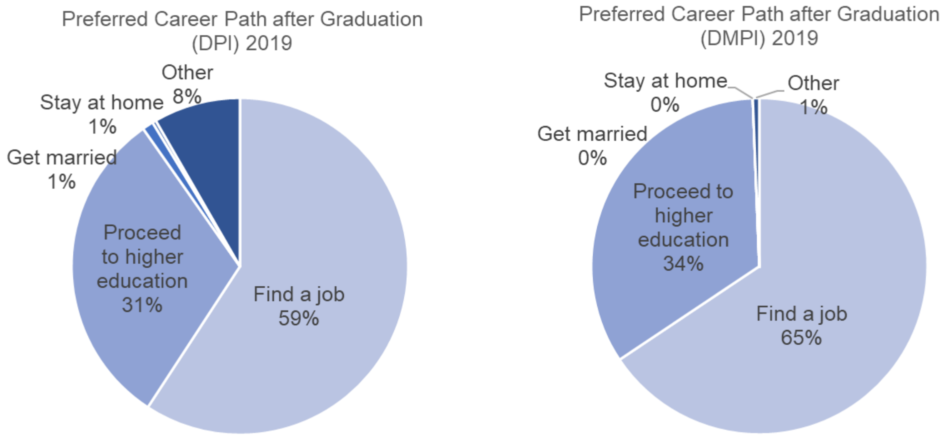


Figure 1. Preferred career path after graduation in 2019

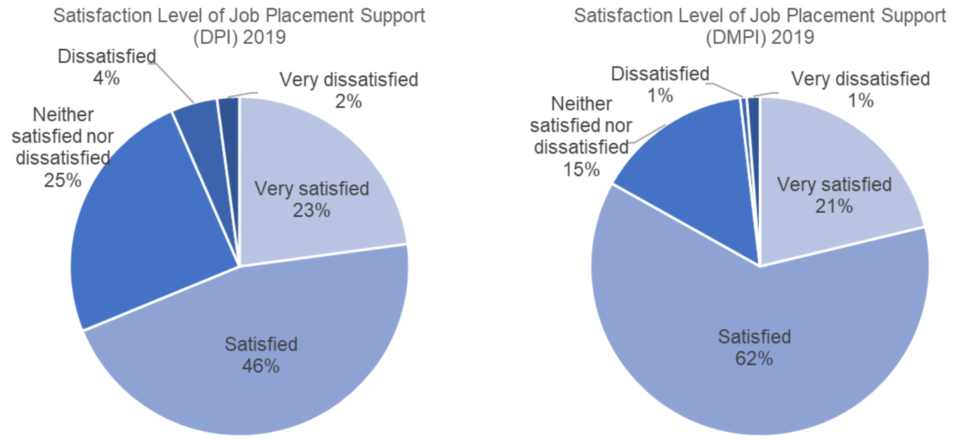


Figure 2. Satisfaction level with job placement support in 2019

2. Pre-graduation questionnaire survey results in 2021

The number of respondents to the pre-graduation questionnaire survey at DPI and DMPI in 2021 are shown in Tables 14 and 15, respectively. Similar to the previous ones, the survey was conducted in February 2021, when the final exams before graduation were conducted for all 8th semester students of the target technologies.

Table 14. Number of Pre-Graduation Survey Respondents (DPI) in 2021

Technology	Male	Female	Total
Electrical	187 (92%)	17 (8%)	204
Electronics	83 (88%)	11 (12%)	94
Mechanical	201 (94%)	12 (6%)	213
Computer	120 (81%)	28 (19%)	148
Total	591 (90%)	68 (10%)	659

Table 15. Number of Pre-Graduation Survey Respondents (DMPI) in 2021

Technology	Total
Electronics	81
Computer	72
Total	153

The DPI and DMPI survey results are presented in Figures 3 and 4, respectively. Regarding students' preferred career paths after graduation, it was revealed that 59% of DPI students wanted to get a job, which is the same as the last time. However, for DMPI students, the number of students who wanted to get a job decreased to 45% (was 65% the last time), while the number of students who wanted to proceed to higher education increased. It may have been caused by the deterioration of the employment situation due to COVID-19, especially the difficulty women faced in finding a job. Regarding the level of satisfaction with job placement support, the total of "very satisfied" (31%) and "satisfied" (46%) was 77% at DPI, while the total of "very satisfied" (17%) and "satisfied" (74%) was 91% at DMPI. Their satisfaction level was higher than that the last time.

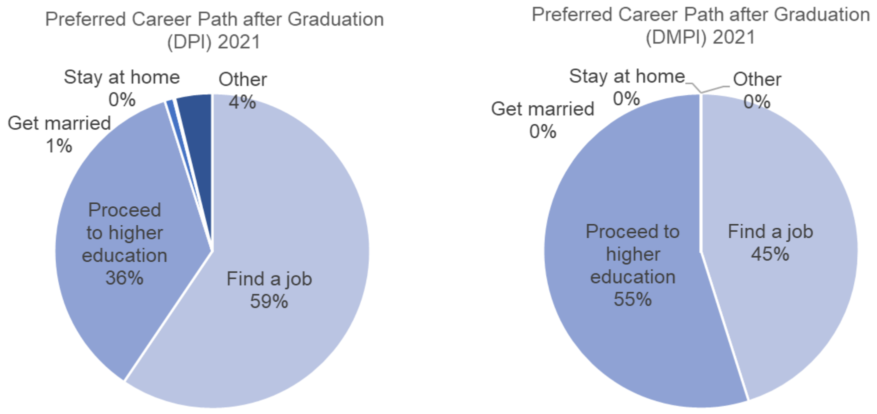


Figure 3. Preferred career path after graduation in 2021

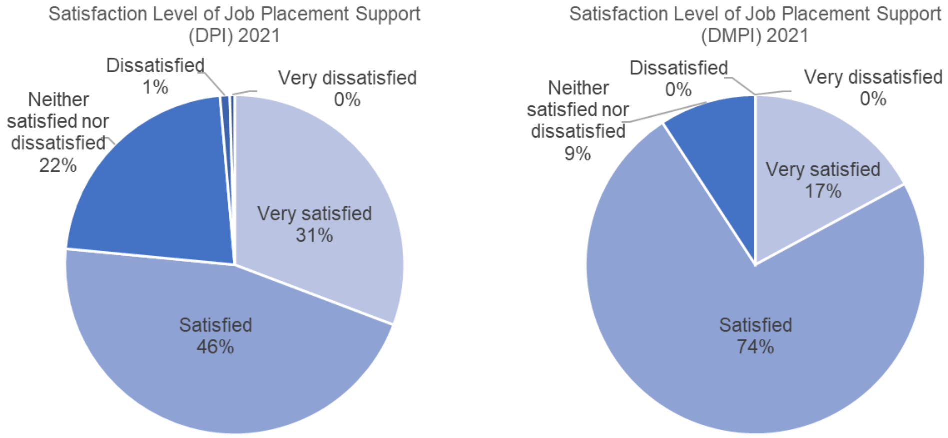


Figure 4. Satisfaction level with job placement support in 2021

Employment status survey one year after graduation

Among the above graduates, we conducted a questionnaire survey on their employment situation one year after graduation, targeting students who wanted to get a job. The survey for 2019 graduates was conducted from September to October 2020, approximately one year after graduation. The number of DPI and DMPI questionnaire survey targets and the number of respondents are shown in Tables 16 and 17, respectively.

Table 16. Number of Respondents to Employment Status Survey 1 Year After Graduation (DPI) 2019 Graduates

Technology	Target Numbers (Students who wanted to get a job before graduation)	Respondents	Response rate
Electrical	128	79	62%
Electronics	78	28	36%
Mechanical	113	58	51%
Computer	44	20	45%
Total	363	185	51%

Table 17. Number of Respondents to Employment Status Survey 1 Year After Graduation (DMPI) 2019 Graduates

Technology	Target Numbers (Students who wanted to get a job before graduation)	Respondents	Response rate
Electronics	44	17	39%
Computer	62	37	60%
Total	106	54	51%

Figures 5 and 6 show the results of a survey on the employment rate of students who wanted to get a job after one year of graduation. The employment rate of DPI graduates one year after graduation was 17%, while those of DMPI was 9%. The employment rate was extremely low for both institutes.

This rate is considerably lower than the employment rate of 48% for graduates of polytechnic institutes in a report issued by the WB in 2018. The WB's survey was conducted among graduates from the past two years, so it was not possible to make a general comparison. However, it can be said that the impact of the difficulty in finding a job due to COVID-19 was strongly reflected in the results. Figures 7 and 8 show the period of employment of DPI and DMPI graduates who found a job on a monthly basis, respectively. According to the figures, since only a few graduates have been able to find a job since the end of March 2020, when the COVID-19 pandemic spread worldwide, it can be said that COVID-19 has strongly influenced students' employment difficulties.

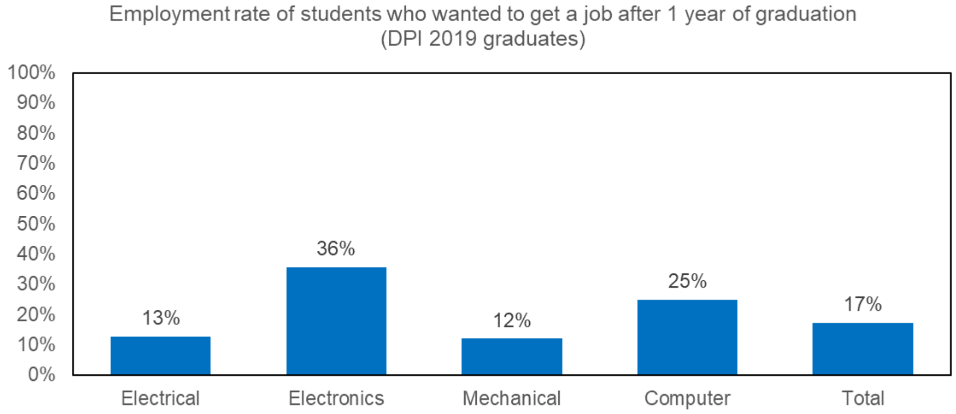


Figure 5. Employment rate of students who wanted to get a job one year after graduation (DPI) 2019 graduates

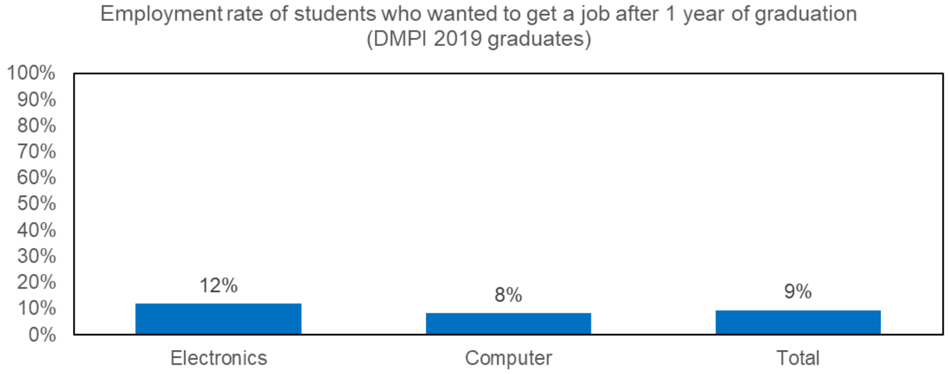


Figure 6. Employment rate of students who wanted to get a job one year after graduation (DMPI) 2019 graduates

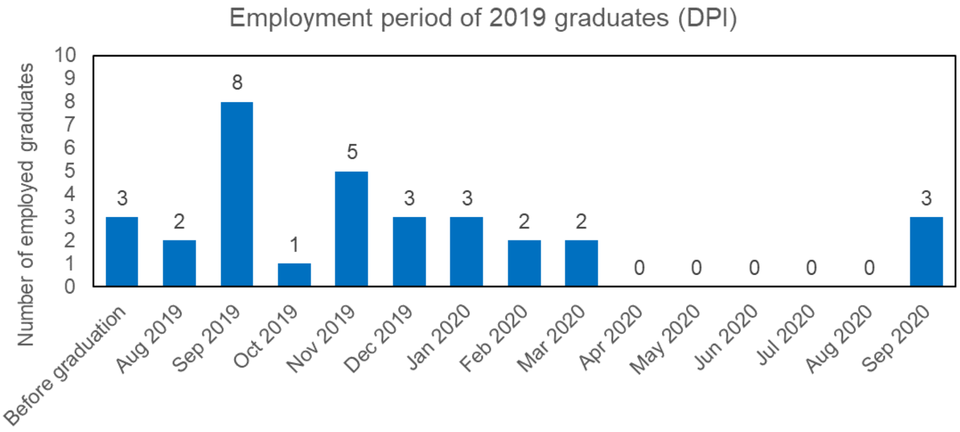


Figure 7. Employment period of students who got a job (DPI) 2019 graduates

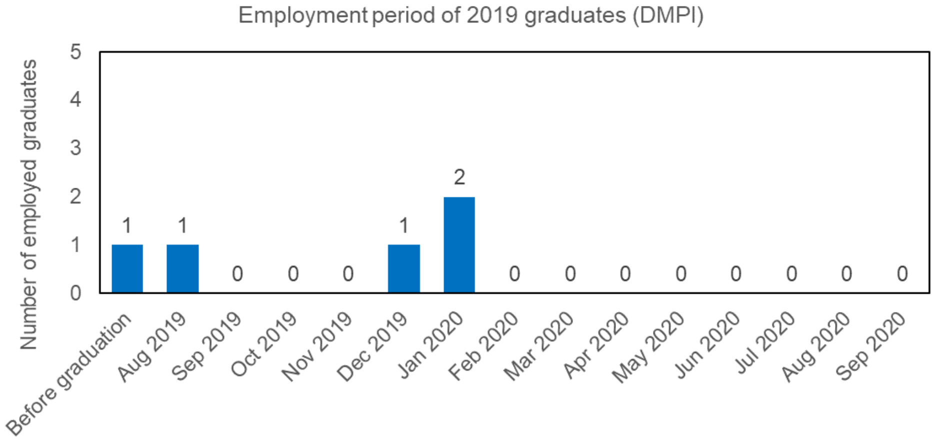


Figure 8. Employment period of students who got a job (DMPI) 2019 graduates

The survey for 2021 graduates was conducted from March to April 2022, approximately one year after graduation. The number of DPI and DMPI questionnaire survey targets and the number of respondents are shown in Tables 18 and 19, respectively.

Table 18. Number of Respondents to Employment Status Survey 1 Year After Graduation (DPI) 2021 Graduates

Technology	Target Numbers (Students who wanted to get a job before graduation)	Respondents	Response rate
Electrical	118	65	55%
Electronics	49	24	49%
Mechanical	158	87	55%
Computer	82	31	38%
Total	407	207	51%

Table 19. Number of Respondents to Employment Status Survey 1 Year After Graduation (DMPI) 2021 Graduates

Technology	Target Numbers (Students who wanted to get a job before graduation)	Respondents	Response rate
Electronics	36	23	64%
Computer	33	15	45%
Total	69	38	55%

Figures 9 and 10 show the results of a survey on the employment rate of students who wanted to get a job after one year of graduation. The employment rate of DPI graduates one year after graduation was 23%, while those of DMPI was 16%. The employment rate was increased by 6-7% compared to the results of 2019 graduates. It is probable that this is because the impact of employment difficulties due to the COVID-19 pandemic has been somewhat mitigated compared to 2019. Figures 11 and 12 show the period of employment of DPI and DMPI graduates who found a job on a monthly basis, respectively. Compared to 2019, it can be seen that graduates are hired throughout the year.

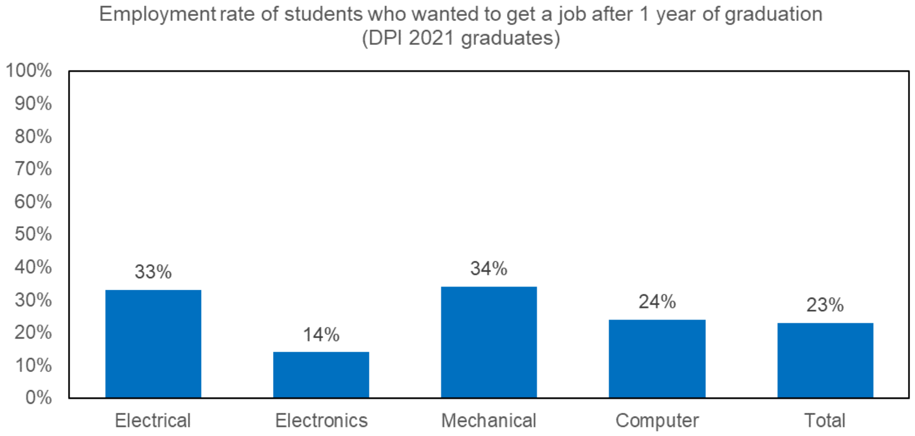


Figure 9. Employment rate of students who wanted to get a job one year after graduation (DPI) 2021 graduates

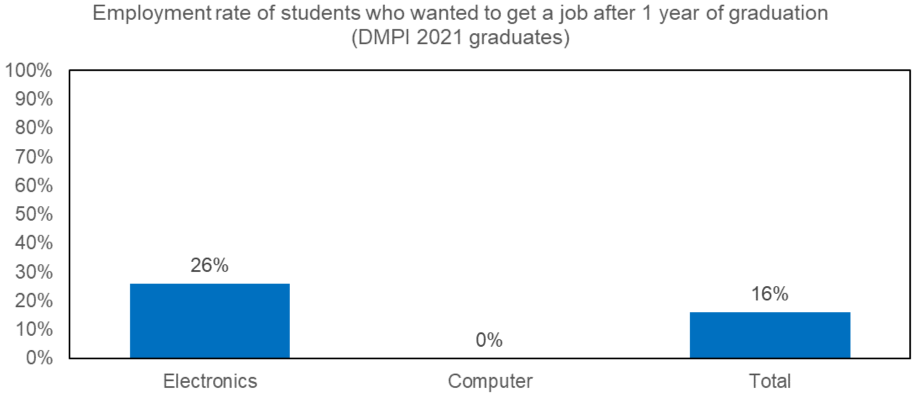


Figure 10. Employment rate of students who wanted to get a job one year after graduation (DMPI) 2021 graduates

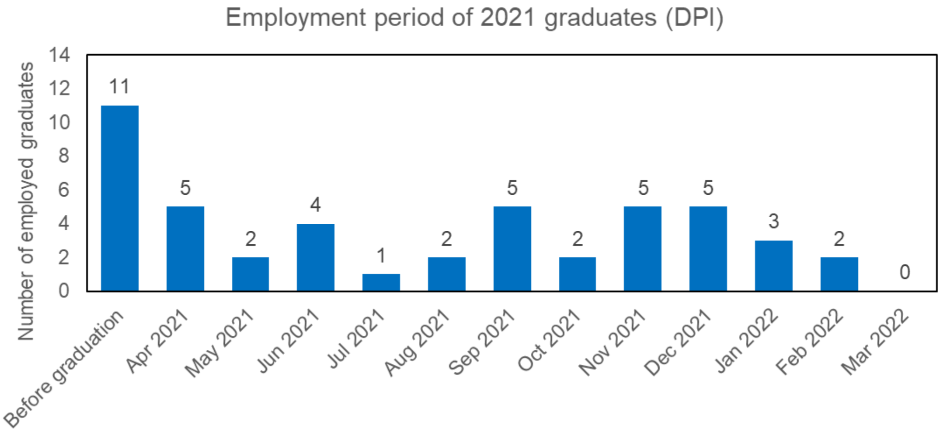


Figure 11. Employment period of students who got a job (DPI) 2021 graduates

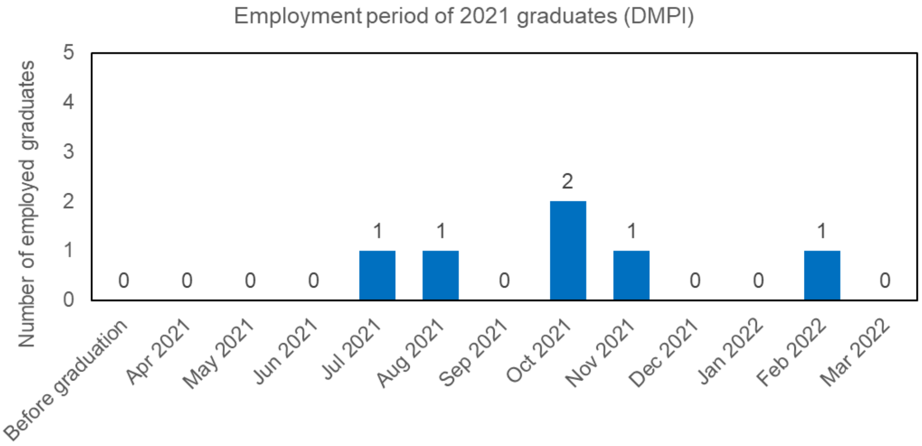


Figure 12. Employment period of students who got a job (DMPI) 2021 graduates

Satisfaction survey of companies that hired graduates

A satisfaction survey was conducted for companies that hired these graduates. It was conducted from February 2021 to July 2021. Table 20 shows the numbers of targeted and responding companies.

Table 20. Number of companies responded to the company satisfaction survey

Institute	Number of Target Company (Companies that hired graduates)	Number of Responded Companies	Response Rate
DPI	32	19	59%
DMPI	5	3	60%

Figure 13 shows the results of a survey on satisfaction with students from companies that hired DPI and DMPI graduates in 2019. As a result of the survey, the total of "very satisfied" (5%) and "satisfied" (79%) was 84% at DPI, while "satisfied" was 100% at DMPI. In particular, DMPI's results can cannot be generalized because of the small number of samples, but it was found that the satisfaction level of companies with DPI and DMPI graduates tends to be high.

Figure 13. Company Satisfaction Survey Results

Activity 4-3. The job placement cells of the pilot polytechnic institutes in Dhaka City promote communication with industry by organizing lectures and/or recruitment seminars, coordinating internship programs, and so forth.

(1) Coordination of Internship

In addition to the coordination of internships with local companies by the DPI and DMPI job placement offices shown in Tables 9 and 10, internships in Japanese companies are shown in Table 21 below.

Table 21. Accepted internships by Japanese companies

No.	Name of Company	Institute	Technology	Number of accepted students	Accepted Period
1	Maruhisa Pacific Co., Ltd.	DPI	Mechanical	1	Feb.-Mar. 2020*
		DPI	Electronics	1	Feb.-Mar. 2020*
		DPI	Mechanical	2	Dec.-Mar. 2022*
2	Kaicom Solutions Japan Co. Ltd.	DPI	Computer	1	Feb.-Mar. 2020*
		DPI	Computer	2	Dec.-Mar. 2022*

*The internship that started in February 2020 was to be held until the end of April 2020, but ended at the end of March 2020 due to the closure of educational institutions nationwide by COVID-19.

When accepting internships at Japanese companies, the candidates were listed and selected based on their resumes, in cooperation with the job placement support office and the project team. Mock interviews were conducted with those who passed the document screening. Subsequently, a recruitment interview was conducted by the accepting companies, and the students who passed were hired as interns.

(2) Job Placement Seminars

Table 19 indicates the seminars on job placement support for DPI and DMPI students that were held in cooperation with the industry.

Table 22. Seminars on Job Placement Support

Seminar Title	Institute	Technology	Number of Attendees	Implementation period
Internship Preparation Seminar (In-person)	DPI	Electrical	All students	Jan. 2020
	DPI	Electronics	All students	Jan. 2020
	DPI	Mechanical	All students	Jan. 2020
	DPI	Computer	All students	Jan. 2020
	DMPI	Electronics	All students	Feb. 2020
	DMPI	Computer	All students	Feb. 2020
Job Searching Process & Methods (Online)	DPI	Electrical	39	May 2021
	DPI	Electronics	29	May 2021
	DPI	Mechanical	74	May 2021
	DPI	Computer	25	Apr. 2021
	DMPI	Electronics	22	May 2021
	DMPI	Computer	22	Apr. 2021
How to Write Resume and Cover Letter (Online)	DPI	Electrical	21	June 2021
	DPI	Electronics	13	June 2021
	DPI	Mechanical	25	June 2021
	DPI	Computer	3	July 2021
	DMPI	Electronics	26	June 2021
	DMPI	Computer	20	June 2021
Experience Sharing by Ex-students (Online)	DPI	Mechanical	5	Sep. 2021
	DPI	Computer	80	Oct. 2021
	DMPI	Computer	11	Sep. 2021
How to Face Job Interview (Online)	DPI	Electrical	9	Sep. 2021
	DPI	Electronics	9	Sep. 2021
	DPI	Mechanical	100	Oct. 2021
	DPI	Computer	18	Sep. 2021
	DMPI	Electronics	50	Apr. 2022
	DMPI	Computer	11	Sep. 2021

Most of the seminars were held online in the midst of COVID-19, but the students who participated were highly satisfied, and they learned practically how to write resumes and how to take job interviews, which were highly needed by students. Local faculty members such as the job placement officers and the heads of the department also participated in the seminar. Through the seminars, information of seminar lecturers and know-how for conducting online seminars were shared with the faculty members so that they could continue to carry out the seminars independently in the future.

(3) Competency Mapping Workshop

To reflect the needs of the industry in the educational content of DPI and DMPI, a competency mapping workshop, which was one of the activities in the action plan, was jointly held by DPI and DMPI on December 12, 2019. At the workshop, 16 local companies were invited, and the DPI and

DMPI heads of department and teachers in charge of model subjects participated in the workshop and worked together, with half of the people from industry and other half of the people from DPI and DMPI. The participants had discussion based on the practical training list of model subjects set by BTEB for each technology, and analyzed what was lacking in the existing training list from the viewpoint of the technology actually required for the company. After that, new training items were added to the list in the workshop.

Activity 4-4. The job placement cells at the pilot polytechnic institutes in Dhaka City enhance career counselling and matching support for employment.

(1) Job Matching

Establishment of Job Placement Support Facebook page

From the end of March 2020 to September 2021, educational institutions throughout Bangladesh were closed owing to the COVID-19 pandemic, and pilot institutes were closed, too. During this time, it was difficult to directly match jobs with students, so the project team and job placement cells established a Facebook page for job placement support at each pilot institute and distributed job information and video recordings of online job placement support seminars through them. As of March 2022, approximately 3,200 followers are registered on the DPI job placement support Facebook page, and approximately 1,400 followers are registered on the DMPI job placement support Facebook page, through which information has been continuously shared. In addition, job matching was carried out through the Facebook page, and the project supported document screening and recruitment interviews. In the job matching, the project team collected job vacancy and communicated with companies, and DPI and DMPI faculty members including the job placement cells collected CVs of candidates and conducted document screening. As a result, one DPI computer technology student was hired as field officer of the organization that implements the support project in Cox’s Bazar, while one DMPI electronics technology student was hired by a local company called ME SOLshare. In addition, one DPI student who was accepted as an intern at a Japanese company in 2021 was hired as a technical staff after the internship.

Online industry-academia collaboration event with Japanese companies

As part of the 50th anniversary of the establishment of diplomatic relations between Japan and Bangladesh by the Embassy of Japan in Bangladesh, the project team in cooperation with DPI and DMPI held the “Online Industry-academia Collaboration Event Between Japanese Companies and Polytechnic Institute 2022”. At the event, the project team recruited companies, and DPI and DMPI recruited students and graduates, respectively. The outline of the event is as follows.

1. Objective

Human resource exchange between DPI/DMPI and Japanese companies operating in Bangladesh was facilitated as part of the industry-academia collaboration support for DPI/DMPI in the JICA project

2. Date and Time

   March 23 (Wed.) 10:00-15:10 Bangladesh time, 13:00-18:10 Japan time

   March 24 (Thu.) 10:00-12:30 Bangladesh time, 13:00-15:30 Japan time

3. Methodology

   Online event by Zoom platform

4. Jointly Hosted by

   JICA Bangladesh Office

   Directorate of Technical Education (DTE), Ministry of Education, Bangladesh

5. Supported by

   Japanese Commerce & Industry Association in Dhaka (JCIAD)

   JETRO Dhaka

6. Participating Japanese Companies

   The following six Japanese companies operating in Bangladesh

   - Furushima (BD) Limited
   - Sanyo Engineering and Construction Inc.
   - Kaicom Solutions Japan BD Co. Ltd.
   - YKK Bangladesh Pte Ltd.
   - SUN Co. Ltd.
   - Tekken Corporation

7. Roles of the Participating Companies

   - Online Presentation: 40 minutes (Presentation 20 minutes + Q&A 20 minutes)

     Presentation Topic : (1) Introduction of the Company (Business Contents), (2) Human Resource Needs of Technical Staff, etc.
   - If the company was willing to recruit DPI and DMPI students, the project would support the company's recruiting activities, such as applicant selection, job interviews, and pre-employment training.

8. Target Groups and number of participants

   - Last year's DPI and DMPI students and graduates in the past 2 years in the target technologies
   - Total number of registered students: 1,033, number of participants in the two-day event: Approximately 400

9. Presentation Language: Bengali or Japanese (from Japanese to Bengali interpretation available)
10. Program: The program of the event is as follows.

Table 23. Online industry-academia collaboration event program

Bangladesh Time	Japan Time	Contents	Speaker
1st day: March 23			
10:00-10:10	13:00-13:10	Program Introduction	JICA Project Team
10:10-10:20	13:10-13:20	Opening Remarks	JICA Bangladesh Office
10:20-10:40	13:20-13:40	Speech and Lecture	・JCIAD ・JETRO Dhaka
10:40-10:50	13:40-13:50	Presentation on DPI students	Teacher of DPI
10:50-11:00	13:50-14:00	Presentation on DMPI students	Teacher of DMPI
11:00-11:10	14:00-14:10	Opening Remarks	Directorate of Technical Education (DTE), Ministry of Education
11:10-11:20	14:10-14:20	Break	
11:20-12:00	14:20-15:00	Presentation by Japanese Company 1	Furushima (BD) Limited
12:00-12:40	15:00-15:40	Presentation by Japanese Company 2	Sanyo Engineering and Construction Inc.
12:40-13:40	15:40-16:40	Lunch Break	
13:40-14:20	16:40-17:20	Presentation by Japanese Company 3	Kaicom Solutions Japan BD Co. Ltd.
14:20-15:00	17:20-18:00	Presentation by Japanese Company 4	YKK Bangladesh Pte Ltd.
15:00-15:10	18:00-18:10	Closing of the 1st day	JICA Project Team
2nd day: March 24			
10:00-10:10	13:00-13:10	Introduction of the 2nd day's Program	JICA Project Team
10:10-10:20	13:10-13:20	Presentation on DPI students	Teacher of DPI
10:20-10:30	13:20-13:30	Presentation on DMPI students	Teacher of DMPI
10:30-10:50	13:30-13:50	Presentation on Internship Experience at Japanese Company	Student of DPI
10:50-11:00	13:50-14:00	Break	
11:00-11:40	14:00-14:40	Presentation by Japanese Company 5	SUN Co. Ltd.
11:40-12:20	14:40-15:20	Presentation by Japanese Company 6	Tekken Corporation
12:20-12:30	15:20-15:30	Closing Remarks	・Embassy of Japan in Bangladesh ・Principal of DPI ・Principal of DMPI ・Directorate of Technical Education (DTE), Ministry of Education

11. Participation fee

Free of charge for both companies and students

12. Means of PR

- In recruiting participating companies, the e-mail newsletter of JCIAD and Facebook of JETRO Dhaka, as well as the existing network of the project, were utilized.
- In recruiting participating students, information was distributed through the student and graduation database that was constructed by the project through the previous survey and the messenger group for the then current students of DPI and DMPI.

13. Questionnaire and interview results for participants

- All the 6 Japanese companies responded an online questionnaire survey. As a result, all 6 companies answered " It was good for our company to have participated in the event.", and the reasons were "awareness of the company in Bangladesh was increased" and "it was a good opportunity to hire excellent young engineers", etc. 5 out of the 6 companies answered that they would like to participate again next time, and the remaining one company answered that they would participate if circumstances permit. Regarding the method of conducting the event, 3 companies answered that "face-to-face is better", 2 companies answered that "online is better", and 1 company answered that "hybrid style with both face-to-face and online is better", indicating that there was a need for face-to-face event. In addition, since the 2 companies actually requested to hire DPI and DMPI students, the project team and faculty members of DPI and DMPI are proceeding with job matching with the students participated in the event.

- As a result of an online questionnaire survey of the participated students, 160 out of about 400 participants responded. As a result, 49% of the participants answered that they were "very satisfied" and 50% answered that they were "satisfied", which made the event highly satisfying for the students. In addition, 94% answered that they would like to participate again next time.
- As a result of an interview with DPI and DMPI faculty members, a DPI faculty member said, "This was a very good opportunity, so I would like to continue this kind of event. If possible, it would be better if it could be held face-to-face rather than online. I think it would be good if the event could be held more frequently". A DMPI faculty member commented, "I hope that more female students will be accepted as interns. I hope that through the internship experience, more job opportunities for female students will be provided".

14. Outcome of the event

The network for human resource exchange between DPI/DMPI and Japanese companies was established through the event, and 2 Japanese companies actually offered job opportunities for DPI and DMPI students after the event.

(2) Implementation of career guidance and counseling

Career guidance and counseling training

The project team hold a Career guidance and counseling training from March 1 to 8, 2022 for two DPI and DMPI job placement officers, and two other career guidance facilitators by the career guidance trainer introduced by ILO. A total of five facilitators, including the career guidance trainer and four trained facilitators, prepared career guidance and counseling workshops for the final-semester students of DPI and DMPI, as described below.

Career guidance and counseling workshop for students

The four facilitators trained by the above training and one trainer prepared the teaching materials for the career guidance and counseling workshop for DPI and DMPI students. In the workshop, instruction on the contents such as (1) career selection and preparation in life, (2) importance and method of self-understanding, (3) importance and method of job understanding, (4) example of job selection for each technology, (5) career development for the future, (6) how to search job vacancy, (7) how to write CV will be given with group works among students. As a result of discussions with

DTE regarding the implementation method and schedule of the workshop, it is necessary to continue to consider the cost sharing with the DTE side, so it was decided to create a video of career guidance by using the developed teaching materials and it is provided to students through the job placement Facebook pages in the 1st period of the project. The face-to-face workshop will be held in the 2nd period.

Activity 4-5. The pilot polytechnic institute outside Dhaka City assigns faculty member(s) and develops an action plan for promoting collaboration with industry, referring to the activities at the pilot polytechnic institutes in Dhaka City and according to the local socioeconomic environment of its own.

Activities were implemented in the 2nd period of the project for the pilot institute outside Dhaka.

Activity 4-6. The pilot polytechnic institute outside Dhaka City implements the action plan for promoting collaboration with industry.

Activities were implemented in the 2nd period of the project for the pilot institute outside Dhaka.

2.6 Other Activities

2.6.1 Project Public Relations

The project conducted the following public relations (PR) activities.

(1) Making a Project PR brochure (See Appendix 1-6); and

(2) Launching a Facebook[1] page, posting of the article about project activities

Table 24. List of the articles on Facebook page

Date	Content
Jan. 4, 2021	Introduction of the project
Jan. 17, 2021	Implementation of trial TOT
Jan. 28, 2021	Implementation of 1st TOT of Computer Technology
Apr. 8, 2021	Competency Mapping Workshop
Apr. 15, 2021	About the DMPI Alumni Network
May 31, 2021	Implementation of student internships
Oct. 12, 2021	Introduction of equipment provided by JICA for practical training
Oct. 14, 2021	About the Job Placement Office Facebook page
Oct. 17, 2021	Workshops for the development of hands-on manuals
Dec. 30, 2021	Implementation of Remote TOT (Mechanical Technology)
Jan. 25, 2022	Introduction to the project and remote TOT (Published on the Facebook page of the JICA Bangladesh office)

2.6.2 Training in Japan

In fiscal year 2019, a national training program, “Strengthening Technical Education in Bangladesh through Learning from Japanese KOSEN” was conducted. The details of the training are described

---

[1] https://www.facebook.com/JICABangladesh.TCP.ImprovementOfTechnicalEducaiton

below.

(1) Course Name

Training in Japan of Strengthening Technical Education in Bangladesh through Learning from Japanese KOSEN

(2) Training Period

From November 5 to 20, 2019

(3) Number of trainees

The following 17 people participated in the training.

Table 25. List of Trainees

Group 1		
Name	Organization	Title
Mr. Ajit Kumar Ghosh	TMED	Additional Secretary
Dr. Md. Morad Hossain Mollah	BTEB	Chairman
Mr. Md. Jahangir Alam	DTE	Director (Planning and Development)
Mr. Md. Ramjan Ali	TTTC	Principal
Mr. Kazi Zakir Hossain	DPI	Principal
Ms. Shahana Begum	DMPI	Principal
Mr. Mohammad Abdul Majid	Narshingdy TSC	Principal

Group 2		
Name	Organization	Title
Ms. Sabera Sultana	TTTC	Assistant Professor of Electrical, Electronics Engineering
Mr. Md. Saiful Islam	TTTC	Assistant Professor of Mechanical
Mr. Md. Rezaul Karim	DPI	Vice Principal
Mr. Md. Golam Mostafa	DPI	HoD of Mechanical Technology
Mr. Zahed Ahmad Chowdhury	DPI	HoD of Computer Technology
Ms. Shiuly Rani Biswas	DPI	HoD of Electrical Technology
Mr. Md. Nuruzzaman	DPI	HoD of Electronics Technology
Ms. Saida Momtaz Zubaida Iqbal	DMPI	HoD of Electronics Technology
Mr. Mohammad Ashraf	DMPI	HoD of Computer Technology
Mr. Sayful Islam	DTE	Attached Officer (Planning and Dev.)

(4) Training Content

（a）Objectives

Project Goal

Based on industry needs, human resources are nurtured at pilot polytechnic institutes through improved technical education in the fields of electrical, electronic, mechanical, and computer technologies.

Training Goal

① Understand the concept of KOSEN education

② Visit KOSEN class and take practical training

③ Learn Japanese industry-academia collaboration

④　Deepen understanding of this project and implement the project smoothly.

（b）Training Schedule

Table 26 presents the schedule of the training.

Table 26. Training Schedule

Date	Day	Time	Activity		Training Venue
			Group 1	Group 2	
Nov 05	Tue	～	Arrival at Haneda Airport		
Nov 06	Wed	10:00 ～ 12:30	Briefing at Tokyo International Center (TIC), JICA Tokyo		TIC
		14:00 ～ 15:00	Visit：Courtesy Call on Human Development Dept. JICA / Lecture		JICA HQ
		15:00 ～ 16:00	Program Orientation		
Nov 07	Thu	9:30 ～ 10:30	Lecture: National Institute of Technology, NIT		Tokyo Kosen
		10:40 ～ 12:00	Visit: Tokyo Kosen Laboratory/Facilities		
		～	Haneda Airport to Shonai Airport		
Nov 08	Fri	10:00 ～ 11:00	Lecture: About Tsuruoka Kosen		Tsuruoka Kosen
		10:45 ～ 12:00	Visit: 4 Departments		
		14:00 ～ 16:00	Visit: MAHLE Engine Components Japan Corporation		MAHLE
Nov 09	Sat	9:30 ～ 11:30	Visit: Hagurosan (Mountain)		Hagurosan
		13:30 ～ 15:45	Preparation for "Workshop: Action Plan Development" Group 1：Certificate Awarding Ceremony		Hotel's Restaurant
Nov 10	Sun	～	Departure from Haneda		

Date	Day	Time	Activity	Training Venue
			Group 2	
Nov 10	Sun	10:00 ～ 12:00	Visit: Kamo Aquarium	Kamo Aquarium
		14:30 ～ 17:00	Visit: Sakata City	Sakata
Nov 11	Mon	10:00 ～ 11:00	Lecture: About Regional Collaboration Center, Tsuruoka Kosen	Tsuruoka Kosen
		11:50 ～ 12:30	Visit: Kosen-Applied science Research Center, K-ARC	K-ARC
		14:30 ～ 15:30	Sony Semiconductor Manufacturing Corporation	Sony
Nov 12	Tue	10:00 ～ 12:00	Lecture: Education System such as MCC and FD at Tsuruoka Kosen	Tsuruoka Kosen
		13:00 ～ 16:00	Lecture: Watching Video "Most Likely Succeed"	
Nov 13	Wed	10:00 ～ 12:00	Visit: Classes at Tsuruoka Kosen/Laboratory/ Presentation by students	Tsuruoka Kosen
		13:30 ～ 15:30	Visit: Classes at Tsuruoka Kosen/Laboratory/ Presentation by students	
Nov 14	Thu	9:00 ～ 12:00	Lecture: Practical training by Kosen professors / Presentations by participants / Discussion	Tsuruoka Kosen
		13:30 ～ 16:15	Lecture: Practical training by Kosen professors / Presentations by participants / Discussion	
Nov 15	Fri	9:00 ～ 11:30	Lecture: Practical training by Kosen professors / Presentations by participants / Discussion	Tsuruoka Kosen
		13:30 ～ 15:30	Lecture: Practical training by Kosen professors / Presentations by participants / Discussion,　Closing ceremony at Tsuruoka Kosen	
Nov 16	Sat	～	Shonai Airport to Haneda Airport	
Nov 17	Sun	～	Work at Hotel and Free time	
Nov 18	Mon	10:10 ～ 12:30	Workshop: Action Plan Development 1	JICA Takebashi
		14:00 ～ 17:00	Workshop: Action Plan Development 2	
Nov 19	Tue	10:00 ～ 11:30	Workshop: Action Plan Development 3	JICA Takebashi
		13:30 ～ 15:00	Presentation	
		15:00 ～ 16:00	Evaluation of the Course / Certificate Awarding Ceremony	
Nov 20	Wed	～	Departure from Narita Airport	

(c) Summary of the training

This training combined lectures, inspections, practical training, workshops, and presentations over a 16-day training period, in line with the training goals mentioned above. First, the JICA Human Development Department gave a lecture on the outline of international cooperation with KOSEN on technical education, based on the cases of each country. Subsequently, trainees learned the mechanism, organization, and education of KOSEN at the head office of the National Institute of Technology (KOSEN KIKOU). At Tokyo KOSEN and Tsuruoka KOSEN, after the characteristics of education at each school were lectured on, the trainees visited each training facility and observed the latest equipment in Japan. In addition, at Tsuruoka KOSEN, the efforts of the Regional Cooperation Center were explained by showing good practices in regional cooperation and training with local companies. In Tsuruoka City, trainees visited Mare Engine Components Japan Co., Ltd. and Sony Semiconductor Manufacturing Corporation in Tsuruoka Industrial Park, and factories and showrooms to learn about Japan's latest technology.

On the 8th to 10th days of training, lectures and practical training were conducted, divided into each technology at Tsuruoka KOSEN. Instead of providing common content, each course was customized according to the needs of the trainees. In electrical and electronic engineering, classes on electrical and electronic circuits, tours of laboratories related to small wind power generation systems, and lectures on Arduino microcontrollers were delivered. In addition to conducting experimental training on operational amplifiers using a PC-based microcomputer, the goals of the 1st period of the project were discussed. In mechanical engineering, laboratory tours, such as drafting classes using 2D and 3D CAD, which is the latest equipment at Tsuruoka KOSEN, were conducted. Laboratories for renewable energy utilization technologies were also presented. In addition, an experimental training of the "Measurement of head loss and friction loss in the pipeline" was introduced. In computer engineering, the syllabus of the Tsuruoka KOSEN information course was shared. Recognition of the goals of the project, explanations of practical training methods, and attitudes related to programming, such as Java, was also discussed. Tours of Java classes and experimental training on the basics of Java were also conducted. On the final day, a presentation based on the content of the training session was conducted.

On the 11th and 12th days of the training, an action plan was created during the group's brainstorming. Through this workshop, the main counterparts voluntarily discussed the details of the project activities, aiming to facilitate the implementation of future tasks. On the final day, after presenting the action plan, an evaluation meeting and a certificate-awarding ceremony were held at the JICA Takebashi.

(5) Outcome of Training

Through the training, the participants were able to deepen their understanding of the concept of KOSEN education by physically observe the KOSEN's classes including their research laboratories. They also learned the way of industry-academia collaboration by visiting the Japanese companies which had close relationship with Tsuruoka KOSEN. In the end of the training in Japan, the participants developed their action plan for improving technical education based on what they learned in Japan.

2.6.3 Collaboration with other donors

The TVET field in Bangladesh is supported by various international organizations and foreign governments, of which the WB, ILO (funded by the EU), and ADB play major roles in supporting polytechnic institutes. The features of these donor programs and their collaboration with this project are described below:

(1) World Bank (WB)

The WB assisted 56 public and private polytechnic institutes across Bangladesh in the Skills and Training Enhancement Project (STEP) from 2010 to 2019. There, a maximum of 100 million yen is provided per institute in the form of an institutional development grant (IDG), based on the institutional development plan (IDP) proposed by each institute. Various activities were conducted, including equipment procurement, teacher training, inviting lecturers from private companies, and employment support for students using the IDG. In addition, policy support for DTE, BTEB, and others, and a monthly stipend of about BDT 800 (about USD 10) for female students were provided. The accelerating and strengthening skills for economic transformation (ASSET) project will be implemented from 2021 to 2026 as the next STEP project. Similar to STEP, ASSET will provide support through IDG to approximately 100 polytechnic institutes (60 public and 40 private). In addition, a model polytechnic institute will be established in collaboration with a TVET institute in Singapore, and support for students with disabilities will be provided.

This project visited the WB's Bangladesh Office in April 2019, when it started, and has been continuously exchanging information since then.

As a specific collaboration, in addition to utilizing the equipment provided by STEP, such as oscilloscopes and PCs in the training of local teachers of this project, the experience of fair job management is utilized in the job placement office of DPI and DMPI. In addition, as a future plan, it will also be discussed to conduct larger-scale training in collaboration with ASSET in the training of local teachers by KOSEN professors in this project.

(2) ILO and EU

ILO implemented the TVET Reform Project from 2007 to 2015, which was funded by the EU. In the TVET Reform Project, the infrastructure of the National Skills Development System (NSDS) was improved, the organization of technical education institutions and management organizations was strengthened, and support was provided to improve the quality of technical education by nongovernment organizations and the private sector and to build a system for admission to university. At the DPI, the TVET Reform Project provided facility and equipment procurement and teacher training for food and chemical technology. The Skills 21 project was implemented from 2017 to 2022, in which the following were held: (1) development of the Bangladesh Qualification Framework (BQF); (2) development of the sector-wide integrated framework for TVET (SWIFT) mechanism; (3) conversion to a model TVET institute for seven TVET educational institutions; and (4) strengthening of two TVET teacher training institutions (TTTC and Vocational Teacher's Training Institute Bogura), to become the Center of Skills Excellence (CSE). Although DPI and DMPI were not included in the model TVET institutes of Skills 21, TTTC was provided with wiring training equipment and electrical work tools in the electrical laboratory.

In this project, the team visited ILO's Bangladesh office in April 2019 when the project started and exchanged information. In addition, because the DTE office of the project was the next door to the EU's project office, information was exchanged regularly.

As a specific collaboration, in consultation with the ILO officer, a career guidance trainer who was trained by ILO conducted training for DPI and DMPI's job placement officers so that they could facilitate career guidance and counseling workshops for their students.

(3) ADB

The ADB has been implementing the Skills for Employment Investment Project (SEIP) from 2014 to 2023. SEIP provides comprehensive labor market skills training for the Bangladeshi government's priority industry sectors (e.g., ready-made garments, leather, construction, light industry, information technology, shipbuilding, etc.). In addition, it is strengthening the quality assurance system for training through TOT to public and private training institutions, and the system for skill development through the establishment of the National Human Resources Development Fund and the National Skills Development Authority (NSDA). Since the SEIP targets short-term training rather than formal education, such as diploma courses, there is no direct support for the pilot institutes of the project. The ADB plans to implement the Technical Education Modernization Project (TEMP; tentative name) after 2022.

Information was exchanged with the ADB in October 2021 in the "Preparatory Survey for The Project for Modernization of Polytechnic Institutes" to discuss the possibility of future collaboration. Since the ADB is highly interested in the technical education improvement guideline developed by this project, information on the contents of the guideline's dissemination workshop held in April 2022 was also shared.

2.7 Project Implementation Structure

In the project, two management bodies—the Joint Coordination Committee (JCC) and Working

Group—were established. The roles and responsibilities of each body were specified, and the members appointed. During the 1st period of the project, four JCC meetings and six working group meetings were held.

2.7.1 Joint Coordination Committee (JCC)

(1) The 1st JCC Meeting

The 1st JCC meeting was held on August 26, 2019, in the DTE conference room chaired by Mr. Rawnak Mahmud, Director General (DG), DTE. A total of 25 people, including representatives of JICA Headquarters and Bangladesh Office; PD of DTE; representatives of TMED, Ministry of Finance, and Ministry of Planning; representatives of BTEB; principals of pilot institutes; and representatives of FBCCI and JCIAD from industry, attended the meeting. Since it was the first JCC, the outline of the project was explained, and the establishment of a working group and the outline of the first training in Japan were discussed. The agenda is as follows (see Attachments 2-5 for the minutes).

Table 27. Agenda of the 1st JCC meeting

No.	Agenda	Person in Charge
1	Opening Remarks	Mr. Rawnak Mahmud, Director General, DTE
2	Presentation of Work plan	—
	Project Summary	Mr. Md. Jahangir Alam Director (Planning & Development)
	Progress of Activities from April to August 2019	Mr. Md. Jahangir Alam Director (Planning & Development)
	Planned Activities in September 2019 to February 2020	Ms. Etsuko Ikeda Chief Advisor of the project
	Establishment of Working Group	Mr. Md. Jahangir Alam Director (Planning & Development)
	Outline of the first Training in Japan in 2019	Ms. Etsuko Ikeda Chief Advisor of the project
	Q&A	—
3	Plan on the 2nd JCC	Mr. Md. Jahangir Alam Director (Planning & Development)
4	Closing Remarks	JICA Bangladesh Office Senior Representative

(2) The 2nd JCC Meeting

The 2nd JCC meeting was held online on April 5, 2021, under the influence of COVID-19, chaired by Mr. Helal Uddin, DG, DTE. A total of 23 people, including the representatives of the JICA Headquarters and Bangladesh Office, PD of DTE, representatives of TMED and ERD, principals of pilot institutes, and representatives of JCIAD, attended the meeting. As the 2nd JCC meeting was held about one and a half years after the first one because of COVID-19 and the change in DG, the progress reports on activities during that period, the list of equipment provided by JICA, and the setting of target values of PDM indicators were discussed in the meeting. The agenda was as follows (see

Attachments 2-6 for the minutes).

Table 28. Agenda of the 2nd JCC meeting

No.	Agenda	Person in Charge
1	Opening Remarks	Mr. Helal Uddin, NDC Director General, DTE
2	Report on Activities from September 2019 to January 2021	—
	Progress of Activities from September 2019 to January 2021	Mr. Md. Jahangir Alam Director (Planning & Development)
	List of Equipment Provided by the Project	Mr. Yusuke Mori Deputy Chief Advisor of the project
3	Planned Activities from February 2021 to July 2021	Mr. Yusuke Mori Deputy Chief Advisor of the project
4	Target Numbers of the PDM Indicators	Mr. Yusuke Mori Deputy Chief Advisor of the project
5	Q&A Plan on the 3rd JCC	Mr. Md. Jahangir Alam Director (Planning & Development)
6	Closing Remarks	JICA Bangladesh Office Senior Representative

(3) The 3rd JCC Meeting

The 3rd JCC meeting was held on November 2, 2021, in the DTE conference room, chaired by Mr. Helal Uddin, DG, DTE. It was attended by 25 people, including representatives of JICA Headquarters and Bangladesh Office, PD of DTE, representatives of TMED, Ministry of Planning, and IMED of Ministry of Finance, principals of pilot institutes, and representatives of JCIAD. Since the 3rd JCC meeting was the first one to be held after the TAPP's approval of this project, the progress of activities from the start of the project up to the present was reported, and the selection of the pilot institute outside Dhaka city for the 2nd period of the project was discussed. The agenda was as follows (see Attachments 2-7 for the minutes).

Table 29. Agenda of the 3rd JCC meeting

No.	Agenda	Person in Charge
1	Opening Remarks	Mr. Helal Uddin, NDC Director General, DTE
2	Progress of activities from September 2020 to September 2021	Mr. Md. Jahangir Alam Director (Planning & Development)
3	Planned activities from July 2021 to June 2022	Mr. Yusuke Mori Chief Advisor of the project
4	Discussion on the pilot polytechnic institute outside of Dhaka from latter half of the project	Mr. Takuya Murata JICA Human Development Department
5	Closing Remarks	JICA Bangladesh Office Senior Representative

(4) The 4th JCC Meeting

The 4th JCC meeting was held on April 13, 2022, in the DTE conference room, chaired by Dr. Md.

Omar Faruque, DG, DTE. It was attended by 27 people, including representatives of JICA Headquarters and Bangladesh Office, PD of DTE, representatives of BTEB, NEC-ECNEC, and ERD, IMED, and FD of Ministry of Finance, principals of pilot institutes, and representatives of JCIAD. In the 4th JCC meeting, discussion was made mainly on the progress and achievement of the PDM indicators, revision of the target values, and the target institute and the overall plan of the 2nd period. It was agreed in this JCC meeting that Cox's Bazar Polytechnic Institute would be officially targeted in the 2nd period. Regarding the revision of the target values of the PDM indicators, the initial target values set in the 2nd JCC, the revised value agreed in the 4th JCC, and the target values for the Cox's Bazar Polytechnic Institute scheduled to be set in the 5th JCC will be officially set together by concluding the RD after the 5th JCC meeting. The agenda was as follows.

Table 30. Agenda of the 4th JCC meeting

No.	Agenda	Person in Charge
1	Opening Remarks	Dr. Md. Omar Faruque Director General, DTE
2	Progress of activities from October 2021 to March 2022	Mr. Md. Aktaruzzaman Director (Planning & Development)
3	Revision and progress of PDM indicators	Mr. Yusuke Mori Chief Advisor of the project
4	Target institutes and plan of the 2nd period of the project	Mr. Yusuke Mori Chief Advisor of the project
5	Q&A Plan on the 5th JCC	Mr. Md. Aktaruzzaman Director (Planning & Development)
6	Closing Remarks	JICA Bangladesh Office Senior Representative

2.7.2 Working Group

(1) The 1st Working Group Meeting

The 1st working group meeting was held at the DPI and DMPI on September 2 and 4, 2019, respectively. An overview of Trial TOT was explained, and each polytechnic institute’s action plan for job placement activities was presented and discussed with the participants. Based on the discussions in the working groups, it was confirmed that the action plans would be finalized in the 2nd working group meeting. The agenda was the same for both the DPI and DMPI meetings, differing only in the presenters.

Table 31. Agenda of 1st Working Group Meeting

No.	Item	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal of DMPI
2	Training of Trainers (TOT)	
	Introduction of Trial TOT	Mr. Yusuke Mori Deputy Chief Advisor of the project
	Assignment of responsibility for TOT’s preparation	Mr. Yusuke Mori Deputy Chief Advisor of the project
	Discussion	—

3	Job Placement Activities	
	Previous Job Placement activities by DPI/DMPI	Mr. Md. Rezaul Karim Vice Principal of DPI Ms. Sayema Aktar Job placement Officer of DMPI
	Job Placement activities of JICA project and purpose of Action Plan	Mr. Yusuke Mori Deputy Chief Advisor of the project
	Introduction of draft Action Plan	Mr. Md. Touhidul Islam Job placement Officer of DPI Ms. Sayema Aktar Job placement Officer of DMPI
	Discussion	—
4	Closing Remarks	Ms. Etsuko Ikeda Chief Advisor of the project

(2) The 2nd Working Group Meeting

The 2nd working group meeting was held at DMPI and DPI on December 3 and 4, 2019, respectively, to report on the Japan training that was conducted in November 2019, and discuss and review the final version of the draft Action Plan for technical education improvement and job placement activities prepared during such training. Since the Action Plan required final approval by the DTE, it was decided that Japanese experts would travel to Bangladesh in January 2020 to brief the DTE on the details of the Action Plan and its activities along with the HoDs of DPI and DMPI. The agenda was the same for both the DPI and DMPI, differing only in the presenters.

Table 32. Agenda of 2nd Working Group Meeting

No.	Item	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
2	Report on the first Training in Japan	
	Overview	Mr. Md. Rezaul Karim, Vice Principal of DPI Ms. Sabera Sultana, Head of Department (HOD), TTTC
	TOT on Mechanical	Mr. Md. Golam Mostafa, HoD, DPI (No presentation in DMPI)
	TOT on Electrical and Electricity	Ms. Shiuly Rani Biswas and Mr. Md. Nuruzzaman, HoD, DPI Ms. Saida Momtaz Zubaida Iqbal, HoD, DMPI
	TOT on Computer	Mr. Zahed Ahmad Chowdhury, HoD, DPI Mr. Mohammad Ashraf, HoD, DMPI
	Discussion	—
3	Discussion of Action Plan	
	Presentation of Action Plan of improvement of technical education of DPI	Mr. Zahed Ahmad Chowdhury, HoD, DPI Mr. Mohammad Ashraf, HoD, DMPI
	Discussion	—
	Presentation of Action Plan of Job Placement Activities at DPI	Mr. Md. Touhidul Islam, Job placement Officer of DPI Ms. Sayema Aktar, Job placement Officer of DMPI
	Discussion	—
4	Micro Controller for Practical Training	Mr. Yusuke Mori,

		Deputy Chief Advisor of the project
5	Preparation on Competency Mapping Workshop	Ms. Etsuko Ikeda, Chief Advisor of the project
6	Closing Remarks	Ms. Etsuko Ikeda, Chief Advisor of the project

(3) The 3rd Working Group Meeting

The 3rd working group meeting was held at the DPI and DMPI on January 20 and 22, 2020. The results of the baseline survey conducted in December were reported. In addition, a list of experimental and experimental sheets is presented. Based on the Competency Mapping Workshop conducted in December, in-house training was held at DPI for four days from January 13 to 16, 2020, and at DMPI for three days from January 15 to 17, 2020. The list of experiments and experiment sheets for the practical classes, mainly model subjects for the new semester starting February 1, 2020, were prepared for training. In addition, with respect to the internship program that will begin in January 2020, a report was provided on the status of acceptance by Japanese companies and the implementation of internship preparation workshops. The agenda was the same for both the DPI and DMPI, differing only in the presenters.

Table 33. Agenda of 3rd Working Group Meeting

No.	Agenda	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI、 Ms. Shahana Begum, Principal (in charge) of DMPI
2	Baseline Survey	
	Sharing Baseline Survey Results	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Discussion	—
3	Finalization of the Experiment Sheet	
	Mechanical	Mr. Md. Golam Mostafa, HoD, DPI (No presentation in DMPI)
	Electrical	Ms. Shiuly Rani Biswas, HoD, DPI (No presentation in DMPI)
	Electronics	Mr. Md. Nuruzzaman, HoD, DPI Ms. Saida Momtaz Zubaida Iqbal, HoD, DMPI
	Computer	Mr. Zahed Ahmad Chowdhury, HoD, DPI Mr. Mohammad Ashraf, HoD, DMPI
4	Industrial Attachment	
	No. of Industries which accept internship from Feb. 1st, 2020	HoDs of Mechanical, Electrical, Electronics, and Computer Technologies
	Progress of Internship at Japanese Companies	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Internship Preparation Workshop	Mr. Md. Rezaul Karim, Vice Principal of DPI Mr. Mohammad Ashraf, HoD, DMPI
5	Closing Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI

(4) The 4th Working Group Meeting

The 4th working group meeting was held on March 12, 2020 at DPI and DMPI. The progress of the activities described in the Action Plan was reviewed, including the list of experiments and the quantities of the experimental sheets in each model subject, which were prepared after the 3rd Working Group Meeting. In addition, the status of the implementation of in-house training after April 2020, which will be the 2nd half of the ongoing semester, the creation of experiment sheets, and the status of PBL implementation in the future, were confirmed. Moreover, the project roadmap, which was prepared by KOSEN professors, was explained, as well as the database of graduates and alumni networks was created. The agenda was the same for both DPI and DMPI with a few exceptions, differing in the presenters.

Table 34. Agenda of 4th Working Group Meeting

No.	Item	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
2	Progress of Action Plan	
	Result of Competency Mapping Workshop and in-house training	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Format to Develop a Detailed Plan of Future Activities	Ms. Ayako Shishido, Project Coordinator of JICA project
	Discussion	—
3	Project Roadmap	
	Introduction of the Roadmap Developed by KOSEN Professors	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Discussion	—
4	Equipment by Japanese Grant Project	
	Purpose of the Grant Project	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Form of Requesting Equipment List	Mr. Yusuke Mori Deputy Chief Advisor of the project
	Discussion	—
5	Ex-Student Database (Alumni Network *only in DMPI）	
	Questionnaire Form and Sample Database	Mr. Zahed Ahmad Chowdhury, HoD, Computer Mr. Mohammad Ashraf, HoD, Computer
	Alumni Network *only in DMPI	Ms. Sayema Aktar, Job Placement Officer
	Discussion	—
6	Closing Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI

(5) The 5th Working Group Meeting

Using Zoom, the 5th working group meetings were held on January 13, 2021, for DPI and on January 18, 2021, for DMPI with the following items on the agenda: (1) report on the current situation of the institute (e.g., transfer of subject teachers); (2) report on the implementation of the remote TOT; (3) schedule for the next remote TOT; and (4) report on job placement activities. In the report on job placement activities, the following steps were discussed: (1) satisfaction survey of companies that have hired graduates; (2) creation of an alumni database; and (3) establishment of an alumni network.

As for DMPI, it was agreed to proceed with these activities, and preparations for them were made. The agenda was the same for both the DPI and DMPI, differing only in the presenters.

Table 35. Agenda of 5th Working Group Meeting

No.	Item	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
2	Report on current situation of the institute	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
	Transfer of subject teachers	
3	Report on the remote TOT	
	Overview	Ms. Etsuko Ikeda, Chief Advisor of the project
	TOT on Mechanical	Ms. Jannatul Ferdousy, Chief Instructor, Mechanical (No presentation in DMPI)
	TOT on Computer	Mr. Zahed Ahmad Chowdhury, HoD, Computer Mr. Mohammad Ashraf, HoD, Computer
	TOT on Electrical	Ms. Shiuly Rani Biswas, HoD, Electrical (No presentation in DMPI)
	Discussion	—
4	Plan for next remote TOT	Ms. Etsuko Ikeda, Chief Advisor of the project
5	Report on Job Placement Activities	
	Report on the result of the questionnaire survey of ex-students	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Report on plan for activities in January	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	Discussion	—
6	Closing Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI

(6) The 6th Working Group Meetings

The 6th working group meetings were conducted remotely via Zoom on July 5, 2021 for DMPI, and July 6, 2021 for DPI. The agenda included: (1) a report on the current situation of the institute (i.e., changes in teachers, changes in positions, additional group members, etc.); (2) plans for future remote TOT implementation (including an explanation of how to access the LMS); (3) policies for developing guidelines for improving technical education; (4) a report on activities related to job placement support; and (5) confirmation of the feasibility of conducting competency-mapping workshops and other events. Regarding the preparation of hands-on manuals for practical training, the teachers explained and discussed the guidelines for the preparation of hands-on manuals for practical training. At the same time, an evaluation chart to evaluate the hands-on manuals prepared by teachers and the grouping of each technology when preparing the manuals was also explained. Regarding the Competency Mapping Workshop, it was agreed that it would be decided based on the future situation since corporate activities were completely suspended during the lockdown caused by the spread of COVID-19. It was also difficult for companies to participate in the workshop remotely. The agenda was the same for both the DPI and DMPI, differing only in the presenters.

Table 36. Agenda of 6th Working Group Meeting

No.	Item	Presenter
1	Opening Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
2	Report on current situation of the institute	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI
	Report on change in staffing of Japanese side	Ms. Etsuko Ikeda, Chief Advisor of the project
3	Plan for implementation of TOT	
	Overview	Mr. Yusuke Mori, Deputy Chief Advisor of the project
	How to access the LMS for computer technology's teachers	Ms. Nanae Yasukawa, Project Coordinator of JICA project
	Discussion	—
4	Policy for developing the guideline for improving technical education	
	Explanation on developing the guideline	Ms. Ayako Shishido, Consultant of JICA project
	Discussion	—
5	Report on job placement support	
	Report on the online job placement seminar	Mr. Yusuke Mori, Deputy Chief Advisor of the project Mr. Md. Touhidul Islam, Job placement Officer of DPI Ms. Sayema Aktar, Job placement Officer of DMPI
	Explanation on the Job Placement Cell's Facebook page	
	Discussion	—
6	Implementation of competency mapping workshop, etc.	Mr. Zahed Ahmad Chowdhury, HoD, Computer Mr. Mohammed Ashraf, HoD, DMPI
7	Closing Remarks	Mr. Kazi Zakir Hossain, Principal of DPI Ms. Shahana Begum, Principal (in charge) of DMPI

2.8 Activities that have changed from the original plan in this reporting period

Owing to the COVID-19 pandemic, travel to Bangladesh was restricted for Japanese experts, and the closure of pilot polytechnic institutes since March 2020 continued until September 2021. In addition, the activities planned at the start of the project were not implemented. During this period, project management continued from Japan through remote TOT, working group meetings, and questionnaires related to employment support. However, it is necessary to review the overall project plan while considering the current situation. In particular, except for the activities of Output 1, for which activities have already been completed, and Output 3, for which full-scale activities are scheduled to begin in the 2nd period, we re-examined how we could achieve the original qualitative and quantitative goals of the 1st period of the project for Outputs 2 and 4, and made the following changes to the activities.

2.8.1 Activities for Output 2

The impacts of the COVID-19 pandemic on Output 2 were as follows.

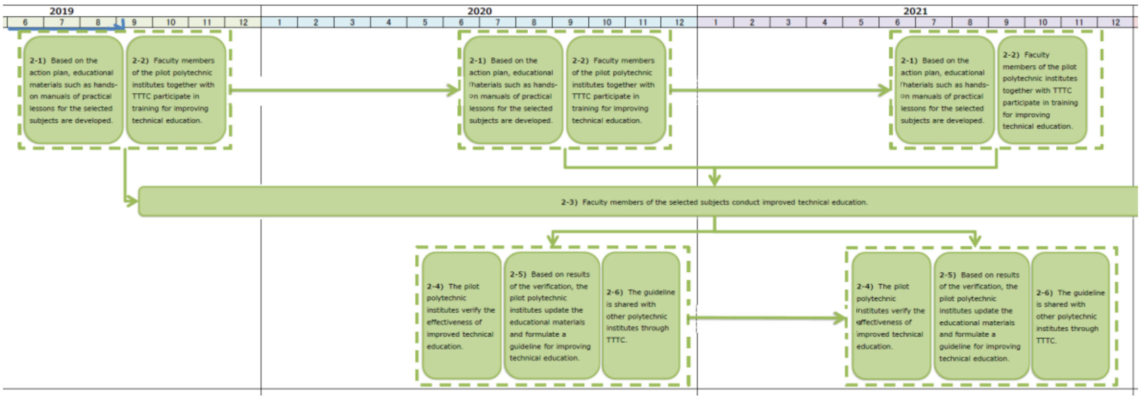
- TOT was conducted remotely from Japan owing to the inability of KOSEN professors to travel to Bangladesh. This made it impossible to conduct the originally planned practical training using local experimental equipment and materials. Therefore, the training topics and methods had to be changed to make it possible to conduct the training remotely.
- Because the pilot polytechnic institutes were closed, the teachers of the model subjects who participated in the TOT were unable to provide practical training to students. Thus, they were unable to provide improved technical education.
- The effectiveness of improving technical education through the preparation of hands-on manuals for practical training and TOT was not verified because improved technical education was not implemented.
- Because the effectiveness of improving technical education had not been verified, there was a delay in developing a guideline for improving technical education based on the verification of the effectiveness of improving technical education.

The initial plan was to improve the practical training skills of teachers through the following steps: (1) preparation of hands-on manuals for practical training by polytechnic teachers; (2) TOT for pilot polytechnic teachers by KOSEN professors; (3) practical training for students by pilot polytechnic teachers; and (4) monitoring and guidance of pilot polytechnic teachers' practical training by KOSEN professors. However, since the pilot polytechnic institutes were closed, the teachers were not able to participate in TOT, which made it difficult to verify the effectiveness of the improvement in technical education. The following changes were made in response to this situation.

(1) The outcome of the technology transfer of teaching skills was that the teachers at each pilot polytechnic institute would be able to prepare hands-on manuals for practical training by themselves.
(2) Instructions were developed for teachers to create hands-on manuals for practical training as guidelines for improving technical education.
(3) The hands-on manual for practical training as a deliverable will include a hands-on manual for practical training, as prepared by the pilot polytechnic teachers.
(4) The effectiveness of Output 2-4 using the above was verified.

The flow of activities before and after the change in accordance with the policy above is illustrated below.

Before



After

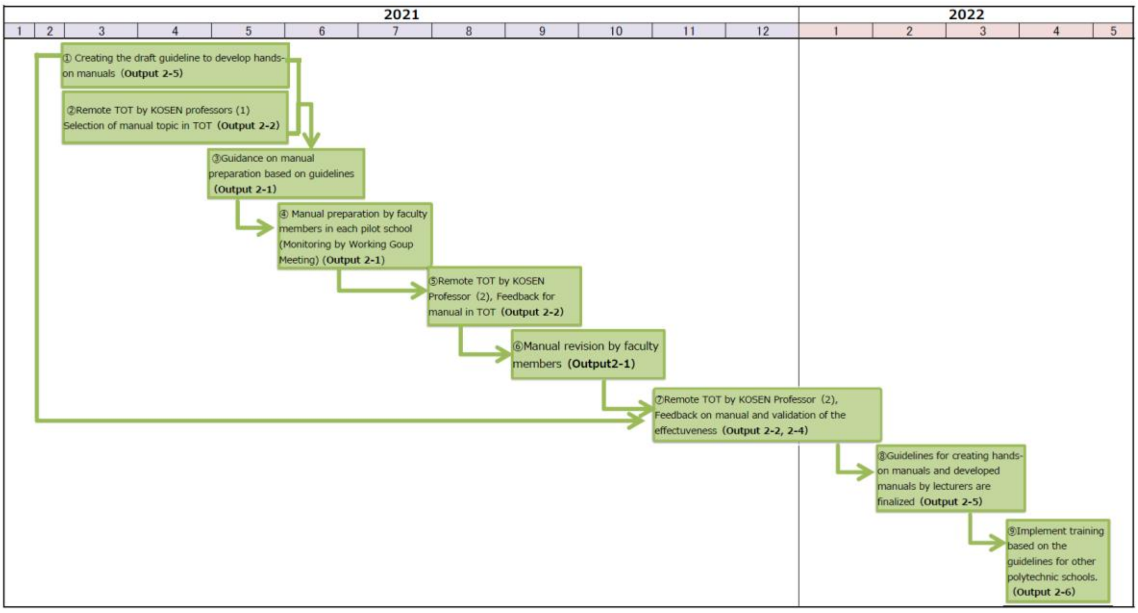


Figure 14. Flow of activities related to Output 2 before and after the change

2.8.2 Activities for Output 4

The impacts of the COVID-19 pandemic on Output 4 are as follows.

- Owing to the stagnation of local economic activities caused by the COVID-19 pandemic, concerns on the transmission of the virus by local companies, and the closure of pilot polytechnic institutes, the project teams were unable to collect information on job openings at local companies, hold job placement seminars and other events in cooperation with the industry, and conduct internships and job matching.
- Because the pilot polytechnic institutes were closed, career counseling for students was not conducted.

In response to the above situation, it was decided to conduct surveys and job placement seminars, and provide career counseling by the end of the 1st period of the project, considering that Japanese experts had been able to travel to Bangladesh since September 2021, and that activities at the pilot institutes had gradually resumed since the same period. In conducting seminars and events, the project team decided to conduct them face-to-face, if possible, or online, if not, considering the local COVID-19 situation.

3 Challenges, Key Innovations, and Lessons Learned in the Implementation of the Project

3.1 Delay in the implementation of activities related to Output 2 (implementation of TOT and preparation of hands-on manuals for practical training and guidelines for improving technical education)

As described in Section 2.8.1, the implementation of TOT, the preparation of hands-on manuals for practical training, and guidelines for the improvement of technical education were delayed because of the inability of KOSEN professors to travel to Bangladesh, the closure of pilot polytechnic institutes, and the inability to verify the effectiveness of the improvement of technical education due to the COVID-19 pandemic.

Countermeasures Taken:

- Conducting remote TOT using an online conference tool (Zoom)
  While preparing the environment in Bangladesh, video cameras and tablets, online conferencing tools, such as Zoom, were utilized to remotely conduct TOT. In addition, we planned TOT using equipment and materials available in both Bangladesh and Japan. After preparing similar equipment and materials, KOSEN professors explained the practical training remotely to the TOT participants in Bangladesh to enable them to perform the same procedure.
- Introduction of Learning Management System (LMS)
  Owing to the COVID-19 pandemic, TOT was conducted remotely from Japan by KOSEN professors to teachers at polytechnic institutes. Because real-time synchronous training using Zoom limits the training time and methods, LMS was introduced to enable asynchronous training. The introduction of this system enables the sharing of training materials, including video files, and implementation of online assignments, thereby improving the efficiency of distance training.
- Change of plan for hands-on manuals for practical training
  For the hands-on manual for practical training, it was initially planned that the deliverable would be a manual with content based on the KOSEN professors' TOT. However, the following steps were taken to improve the practical training skills of the teachers and to provide guidance to the

pilot polytechnic teachers: (1) development of the hands-on manual for practical training by KOSEN professors; (2) training of the pilot polytechnic teachers by KOSEN professors; (3) practical training for students by the pilot polytechnic teachers; and (4) monitoring and guidance by KOSEN professors of the practical training provided by the pilot polytechnic teachers. Since the spread of COVID-19 made it difficult to implement the original plan to verify the effectiveness of the transfer of teaching skills, it was decided that teachers at each pilot polytechnic institute were to prepare their own hands-on manuals for practical training.

- Change of plan for guidelines of the improvement of technical education
  The original plan to develop the guidelines after verifying the effectiveness of improvements in technical education has changed. It was decided to develop guidelines for the improvement of technical education as a guidance manual for teachers to create their own hands-on manuals for practical training and verify the effectiveness of the improvement of technical education through hands-on manuals for practical training.

3.2 Delay in the implementation of activities (job placement seminars, job fairs, and career counseling) related to Output 4

Owing to the stagnation of local economic activities caused by COVID-19, local companies' concerns on the transmission of the virus, and closure of pilot polytechnic institutes, the implementation of activities related to Output 4, such as job placement seminars, job fairs, and career counseling, was delayed.

Countermeasures Taken:

- Conducting activities using an online conference tool (Zoom)
  Utilizing an online conferencing tool, such as Zoom, job placement seminars, such as resume writing and interview preparation, as well as online industry-academia collaboration fairs, were conducted remotely, taking into consideration the dates, times, and frequency to facilitate student participation.
- Utilization of Social Networking Service (SNS)
  Facebook pages of job placement cells at DPI and DMPI were opened to establish a job matching system utilizing the current student and alumni databases. On the Facebook page, the project team and job placement cells distributed job postings and video recordings of online job placement seminars while increasing the number of current students and alumni subscribing to the page.

4 Achievement of Project Purpose and Outputs

Tables 37 to 40 show the achievements of the PDM indicators of the Project Purpose, Outputs 1, 2, and 4 at the end of the 1st period of the project.

Table 37. Achievement of Project Purpose

PDM Indicator	Target	Achievement as of the end of the 1st period
Indicator 1. Satisfaction level of students on technical education at the polytechnic institutes	The target level is **[4.5 on 5-point scale]** for each pilot polytechnic institute. *By the end of the 2nd period (including the pilot institute outside Dhaka)	DPI: **[4.2]** DMPI **[4.5]** The model subject satisfaction survey before the graduation of 2021 graduates indicates that the student satisfaction was generally high, and DMPI reached the target value. The pre-graduation satisfaction survey for the 8th semester students in 2022 is conducted in April 2022 during the final exam.
Indicator 2. Percentage of the graduates employed among those who wanted to get a job	The target percentage will be revised in the 2nd period of the project. (Employment rate will be collected after 1-2 years from graduation)	DPI: **[23%]** DMPI: **[16%]** The employment rate of 2019 graduates is low because of the COVID-19 pandemic. The employment rate of 2021 graduates improved by about 6-7% because of the mitigation of the impact of the COVID-19 pandemic.
Indicator 3. Satisfaction level of companies on the performance of the graduates	The target satisfaction level is **[more than 60%]** for each pilot polytechnic institute. *By the end of the 2nd period (including the pilot institute outside Dhaka)	DPI: **[89%]** DMPI: **[100%]** The satisfaction survey for companies that hired graduates in 2019 indicates the satisfaction level for the hired graduates was high and achieved the target value.

Table 38. Achievement of Output 1

PDM Indicator	Target	Achievement as of the end of the 1st period
Indicator 1. A working group established for improving technical education at each pilot polytechnic institute in Dhaka City	Establishment of a working group at DPI and DMPI	Working groups were established in DPI and DMPI and the target was achieved.
Indicator 2. An action plan to improve technical education at each pilot polytechnic institute in Dhaka City	Development of an action plan at DPI and DMPI	An Action Plan for the first period of the project was developed together with DPI and DMPI.

Table 39. Achievement of Output 2

PDM Indicator	Target	Achievement as of the end of the 1st period
Indicator 1. Number of monitoring on the progress of the	Target number of monitoring is **[17]** by February 2024	Number of monitoring: **[9]** • Monitoring by 4th to 6th

action plan	*By the end of the 2nd period	remote working group meeting: 3 times • On-site monitoring by Japanese experts (September 2021 to April 2022)
Indicator 2. Number of faculty members who participated in developing a guideline for improving technical education	Target number is **[25]**, since guidelines should be developed through discussions from various viewpoints and making trials. *By the end of the 2nd period	Number of teachers who participated in the development of technical education improvement guideline: **[32]** A total of 32 local teachers (TTTC: 9, DPI: 14, DMPI: 9) participated in the guidance of the development of the guideline.
Indicator 3. Number of hands-on manuals verified	Minimum target number is **[43]** and verification will be conducted based on the skill list of each model subject. *By the end of the 2nd period	Number of developed hands-on manuals: **[27]** • Sample manuals developed by KOSEN professors: 11 • Manuals developed by local teachers: 16
Indicator 4. A guideline for improving technical education verified	**[1]** guideline will be made by DPI and DMPI. *By the end of the 2nd period	Number of developed guideline: **[1]** Guideline for improving technical education was developed as a guidebook for developing hands-on manual for practical training.
Indicator 5. Number of training events given by TTTC for polytechnic institutes	After completion of the guideline, at least **[2]** training program to disseminate the guideline will be held for principals and HoDs of other polytechnic institutes in Bangladesh. *By the end of the 2nd period	Number of dissemination workshop: **[1]** An online workshop will be held in April 2022 to disseminate the developed technical education improvement guideline to other polytechnic institutes.

Table 40. Achievement of Output 4

PDM Indicator	Target	Achievement as of the end of the 1st period
Indicator 1. Number of activities implemented by the job placement cells	The target number is **[22]** at DPI and DMPI including lectures/seminars, internship preparation and feedback sessions, questionnaire survey of current students, graduates, and companies which hired the graduates, etc. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.	Number of implemented activities DPI: **[14],** DMPI: **[13]** The following activities were implemented at each of DPI and DMPI. • Internship preparation seminar • Internship interview training (DPI: 2, DMPI: 1) • 1st to 4th online job placement support seminar • Career guidance and counseling workshop

		- 1^{st} to 3^{rd} pre-graduation satisfaction survey - 1^{st} to 2^{nd} employment status survey of ex-students - 1^{st} satisfaction survey of companies' which hired graduates
Indicator 2. Number of job matching by utilizing information of companies	The target number is **[10]** at each pilot institute *By the end of the 2^{nd} period. Target number for Cox's Bazar Polytechnic will be determined in the 2^{nd} period.	Number of job matching DPI: **[2],** DMPI: **[1]** - Job matching with an NGO of Cox's Bazar through the job placement support Facebook page: 1 person (DPI Computer Department) - Job matching with a local company: 1 (DMPI Electronics Department) - Job matching with a Japanese company through internship: 1 person (DPI Computer Department)
Indicator 3. Number of events with companies, such as training, internship, site tour and number of students participated	The target number of events is **[8]** at DPI and DMPI including internship and job fair; the target number of students who have participated in these events is **[3909]** at DPI, **[968]** at DMPI. *By the end of the 2^{nd} period. Target number for Cox's Bazar Polytechnic will be determined in the 2^{nd} period.	Number of implemented events DPI: **[4],** DMPI: **[4]** The following events were held at each of DPI and DMPI. - Internship: 2 - Competency Mapping Workshop: 1 (together by DPI and DMPI) - Online Industry-academia collaboration event: 1 (together by DPI and DMPI) Number of participating students DPI: **[2,207]** - Internship: 1957 - Online Industry-academia collaboration event: 250 DMPI: **[488]** - Internship: 338 - Online Industry-academia collaboration event: 150
Indicator 4. Number of students who had career counselling	The target number is **[2283]** at DPI, **[315]** at DMPI. *By the end of the 2^{nd} period. Target number for Cox's Bazar Polytechnic will be determined in the 2^{nd} period.	DPI: **[registered 761]** DMPI: **[registered 105]** Career Guidance & Counseling Workshop is planned to be held from in April, 2022, for all 8th semester students of the above number of target technologies.
Indicator 5. Number of companies that collaborated with the pilot polytechnic institutes	The target number is **[80]** at DPI and DMPI. *By the end of the 2^{nd} period. Target number for Cox's Bazar	DPI: **[87]** DMPI: **[68]** The following cooperation was implemented in each of

	Polytechnic will be determined in the 2nd period.	DPI and DMPI. <DPI> • MOU signed: 12 • Internship: 53 • Participation in the Competency Mapping Workshop: 16 (together with DPI and DMPI) • Participation in Online Industry-academia collaboration event: 6 (together with DPI and DMPI) <DMPI> • MOU signed: 18 • Internship: 27 • Participation in the Competency Mapping Workshop: 16 (together with DPI and DMPI) • Job placement seminar: 1 • Participation in Online Industry-academia collaboration event: 6 (together with DPI and DMPI)
Indicator 6. Satisfaction level of students regarding the job placement conducted by the pilot polytechnic institutes	Target level is **[85%]** for each pilot polytechnic institute. *By the end of the 2nd period. Target number for Cox's Bazar Polytechnic will be determined in the 2nd period.	DPI: **[77%]** DMPI: **[91%]** As a result of the pre-graduation satisfaction survey conducted in the 8th semester of 2021, the satisfaction level of job placement support was generally high at both institutes, and the target value for DMPI was achieved. The pre-graduation satisfaction survey for the 8th semester students in 2022 is conducted in April 2022 during the final exam.

5 Recommendations for Achieving the Overall Goal

The overall goal of the project is "A technical education model, which was developed at the pilot polytechnic institutes, is widely used at other polytechnic institutes." In the 1st period of the project, starting February 2019, there was the long-term closure of the pilot institutes and the travel restrictions of Japanese experts from March 2020 due to COVID-19. Therefore, most of the activities were carried out remotely from Japan. Considering this situation, the following recommendations emerged from the project:

(1) Development of hands-on manuals for practical training by local teachers based on the guidelines for technical education improvement, and accumulation and sharing of manual data

In the 1st period of the project, guidelines for improving technical education were developed as a guidebook for developing hands-on manuals for practical training by local teachers. By conducting training workshops based on this guideline for teachers at other polytechnic institutes, local teachers who have been trained through the workshop will be able to develop their own hands-on manuals for practical training. It will be possible to share the manuals that were developed by teachers at polytechnic institutes nationwide and utilize the manuals that were developed by other teachers by storing and managing the data of the developed hands-on manuals in one place. Through this, the technical education improvement model that was developed by pilot institutes can be widely shared with other polytechnic institutes. The data will be managed on the introduced LMS at the beginning of the 2nd period of the project, and then be managed on the TTTC website through negotiations with DTE and TTTC to establish a sustainable operation system to be used after the completion of the project.

(2) Online workshops for teachers at polytechnic institutes nationwide

Owing to the COVID-19 pandemic, online training and workshops have rapidly become widespread in Bangladesh, making it possible for people to participate regardless of their location. Since several online teacher training workshops were held in the 1st period of the project and expertise in managing online training and workshops was developed, the project made recommendations to effectively implement online workshops for polytechnic teachers nationwide by utilizing their experience. In the online mode, polytechnic teachers from all over the country can participate, regardless of location or number of people, thus making it possible to effectively promote the dissemination of technical education improvement guidelines.

(3) On-site training of other polytechnic institutes by trained TTTC, DPI, and DMPI teachers

Although it is possible to provide training on general contents regarding the technical education improvement guidelines and development of hands-on manuals through an online workshop, it is more effective to provide face-to-face training using experimental equipment. Therefore, it will be possible to disseminate the technical education model more effectively if TTTC, DPI, and DMPI teachers, who have received direct training from KOSEN professors, visit other polytechnic institutes and directly provided practical training to the teachers there.

(4) Creating a mechanism to improve the employment rate and the number of job matching

In the 1st period of the project, an environment for job matching between students and companies was established through (1) creation of student and graduate database, (2) establishment and operation of job placement support Facebook page, (3) distribution of job vacancy information and acceptance of application from students through the database and Facebook page, (4) Document screening of candidates by faculty members to select appropriate applicants, (5) Providing job opportunities for Japanese companies operating in Bangladesh through internships and online industry-academia collaboration event. In the 2nd phase, it will become possible to improve the employment rate and the number of job matching by systematizing job matching utilizing above resources and establish a system. In addition, by creating a manual on how to operate the established job matching system and transferring the know-how to the job placement officers of DPI and DMPI, the job placement cells of both institutes will be able to provide independent and sustainable job placement support even after the completion of the project.

(5) Establish an effective communication channel between Polytechnic institutes and Japanese industry in Bangladesh.

In the 1st period of the project, an opportunity to reflect the needs of industry in the experiment list of DPI and DMPI was provided through the implementation of the competency mapping workshop. After that, the online industry-academia collaboration event with Japanese companies was held in which gaps with the needs of industry other than technical aspects such as language skills including Japanese, ability to think for themselves, communication skill, and so on, were pointed out. In order to overcome these non-technical issues, it is necessary to change the mindset of both teachers and students at the pilot institutes, and for that purpose, continuous communication with industry is necessary. In the 2nd period, the project will promote effective communication by establishing regular communication channel between Japanese industry and polytechnic teachers and students to change the mindset.

Appendix 1: Materials developed for technical cooperation

- 1-1: Baseline survey report
- 1-2: Action plan for improving technical education
- 1-3: Action plan for job placement support
- 1-4: Hands-on manuals for practical training and experiment
- 1-5: Guideline for improving technical education
- 1-6: Brochure for PR

Appendix 2: Reference materials

- 2-1: PDM
- 2-2-1: Workflow chart (Original)
- 2-2-2: Workflow chart (Revised)
- 2-3: Personnel assignment schedule
- 2-4: Equipment list
- 2-5: Minutes of 1st JCC meeting
- 2-6: Minutes of 2nd JCC meeting
- 2-7: Minutes of 3rd JCC meeting (draft)

Appendix 1-1: Baseline survey report

Baseline Survey Report

Project for Improvement of Technical Education
for Industrial Human Resources Development

Basic Information on the Pilot Polytechnic Institutes

No.	Survey Item	Dhaka Polytechnic Institute (DPI)	Dhaka Mohila Polytechnic Institute (DMPI)
Overview of the Institute			
1	Date of foundation (M/Y)	May 1955	May 1985
2	Scale of the land and building (in area)	27.0 acres (109,265 m2)	4.3 acres (17,401 m2)
3	Qualifications for admission	Secondary School Certificate	Secondary School Certificate
4	Subjects of entrance examination	No exam. According to GPA	No exam. According to GPA
5	Date of start/end of an academic year	July (August) to June	July (August) to June
6	Required period of study (years)	4	4
7	Present organizational structure	The Institute has the following departments of Technology -Architecture -Civil -Chemical -Food -Computer -Electrical -Electronics -Environmental -Mechanical -Automobile -Refrigeration and Air conditioning -NonTech Department	The Institute has the following departments of Technology -Architecture -Electronics -Computer -Electro-Medical -Instrumentation and Process Control (IPC) -Turism and Hospitality -NonTech Department -General Section
8	Number of students in each department/faculty (male and female)	-Mechanical: 150*2(double shift)*4 years=1,200 -Electrical: 150*2(double shift)*4 years=1,200 -Electronics: 100*2(double shift)*4years=800 -Computer: 100*2(double shift)*4years=800 Male: 80%, Female: 20%	-Electronics: 343 -Computer: 375 Female: 100%
9	Number of students per class	About 50	Less than 50
10	Number of teachers in each department/faculty (male and female)	-Mechanical: 19 teachers (2 female) -Electrical: 18 teachers (6 female) -Electronics: 7 teachers (3 female) -Computer: 5 teachers (3 female)	-Electronics: 7 teachers (7 female) -Computer: 5 teachers (4 female)
11	Number of teachers and staff members who are not affiliated with any department/faculty (in each job category)	Lab support staff (not teacher) -Mechanical: 12 -Electrical: 8 -Electronics: 5 -Computer: 3	-Electronics: none -Computer: none
Current Situation of Education			
1	Number of classes and experiments/practical training in each department/faculty whithin an academic year	<Mechanical> 1st year: 540 contact hours 2nd year: 540 contact hours 3rd year: 468 contact hours 4th year: 216 contact hours <Electrical> 1st year: 504 contact hours 2nd year: 396 contact hours 3rd year: 360 contact hours 4th year: 252 contact hours <Electronics> 1st year: 468 contact hours 2nd year: 504 contact hours 3rd year: 468 contact hours 4th year: 216 contact hours <Computer> 1st year: 612 contact hours 2nd year: 648 contact hours 3rd year: 612 contact hours 4th year: 324 contact hours *1 contact hour: 45 minutes	<Electronics> 1st year: 468 contact hours 2nd year: 504 contact hours 3rd year: 468 contact hours 4th year: 216 contact hours <Computer> 1st year: 612 contact hours 2nd year: 648 contact hours 3rd year: 612 contact hours 4th year: 324 contact hours *1 contact hour: 45 minutes

2	Curriculum of each department/faculty	Curriculum Provided by Bangladesh Technical Education Board (BTEB) Link-www.bteb.gov.bd	Curriculum Provided by Bangladesh Technical Education Board (BTEB) Link-www.bteb.gov.bd
3	Syllabus of each department/faculty	Syllabus Provided by Bangladesh Technical Education Board (BTEB) Link-www.bteb.gov.bd	Syllabus Provided by Bangladesh Technical Education Board (BTEB) Link-www.bteb.gov.bd
4	Current facilities and equipment	Physical observation was done by KOSEN professors (see the Institution Observation Sheet)	<Electronics> -Laboratory: Computer Lab (1), Audio video Lab (1), Digital eletronics Lab (1), Electrical Lab (1) -Equipment: Desktop, Multimedia, Projector, Electronics and Communication trainer board, Digital trainer, Motor, Transformer, AC DC trainer board <Computer> -Laboratory: Software Lab (2), Network Lab (1), Hardware Lab (1), Practice Lab (1) -Equipment: Laptop, Multimedia Projector, Smart Board, Desktop, Server, Computer Related Accessories
5	Students' satisfaction with the institute's education (ex. Questionnaire)	See the results of students' satisfaction survey on model subjects and job placement support	See the results of students' satisfaction survey on model subjects and job placement support
Current Situation of Experiment/Practical Training			
1	Structure/component of experiments/practical training	Structure/component of experiments/practical training are described in the BTEB's syllabus	Structure/component of experiments/practical training are described in the BTEB's syllabus
2	Equipment and teaching materials of experiments/practical training	Provide job sheet for experiments/practical training	Provide some materials in limited measure. Equipment list 1. Hand Toolkits 2. Computer Accessories 3. Oscilloscope 4. Trainer board, etc.
3	Evaluation method of experiments/practical training	Exam, demonstration and oral test Grades: A+,A-,B+,B-,C+,C-,D,F(ungraded)	Evaluation Method 1. Job & Experiment Result 2. Oral Test 3. Quiz Test 4. Presentation
4	Situation of experiment/practical training (what point are you caring when experiment or practical training is conducted?)	Lack of material, machine is out of order, students are too many for a machine in a limited time.	The points are 1. Sample sheet supply 2. Logical concept 3. Provide necessary software 4. Data hand book/ operational manual 5. Provide information to link up with the related web address

Institution Observation Sheet

Date: 2019/07-09

Name of Institution: Dhaka Polytechnic Institute

1-1 Educational background of instructors

- Model subject instructors: Diploma 14%, BSc 74%, MSc 10%
- 50% of instructors obtained BSc from TTTC (equivalent to BSc Engineering degree of DUET)

1-2 Challenges and thoughts towards teaching of instructors

- Unofficial and outdated teaching materials are used, and they need to be updated.
- Instructors have to put emphasis on exam preparation to raise students' grades. Therefore, the classes are crammed in a limited number of hours, rather than giving students time to think for themselves.
- The number of students is so large that instructors cannot conduct classes while observing individual students and classes become one-way.
- Even for instructors who have no problem with teaching methods, deeper understanding of the essence of subject is needed.
- Although the experiments are being conducted, instructors need deeper understanding on what theory they are verifying through the experiments.

1-3 Challenges and thought towards teaching of practical training

- The number of students is much larger than the number of equipment, so there is little chance of operating equipment during the experiment.
- There is a lack of experience in conducting experiment with their own hands.

1-4 Challenges and thought towards evaluation of practical training

- There is no evaluation system for students to evaluate each other, only a traditional evaluation system such as a paper test.
- The unified exams are directed and conducted by BTEB, so there is a possibility that instructors cannot give their feedback on the exam results to students.

1-5 Thoughts towards instructors' understanding of the subjects

- Deeper understanding of subjects is needed to improve the teaching method of practical training.
- Although instructors have a general understanding their specialty, there is room for further improvement. Many of them responded that they were too busy with conducting daily classes and had no time for self-improvement.
- Instructors can conduct practical classes by using experiment kit, but have difficulties to conduct similar experiment without the kit.

2-1 Situation of facilities

- In the Mechanical technology, there are machine tools but no experimental apparatus. It seems that experiment is hardly done.
- There were old and new electrical and electronics experimental devices. However, the number of devices is too small compared to the number of students.
- There are two rooms with about 20 PCs. Although the PCs are connected to the internet, there is no network server and it is difficult to consider how to conduct web design practice.
- There is training equipment, but the number is too small to deal with 200 students. Although the equipment is old, there are some new ones and it seems the minimum necessary equipment is in place.
- There are some difficulties for instructors to maintain and repair the equipment by themselves because of the lack of knowledge and experience. There are technical staff who can conduct maintenance at KOSEN, and similar staff might be needed for technical institutes in Bangladesh.

2-2 Institution structure and operation

- The institute is managed under DTE, and its approval is very important for organizational decision-making.
- The organization is well structured, but most of the newly requited instructors need to improve their teaching skills.

3-1 Assessment of curriculum and syllabus

- The curriculum is well developed, and the level of content is high. But there can be seen a gap between the level of curriculum and the actual education.

3-2 Assessment of existing teaching material such as manuals and textbooks

- For computer technology, the textbook in line with the curriculum was confirmed, but any other teaching materials were not observed.
- The textbooks currently being used are outdated and not standard ones.
- There is no manual for teaching practical classes.

4-1 Level of students out of all Bangladesh students

- Relative comparison is not possible because the level of other educational institutions is not known, but it cannot be said that the level is higher compared with Japanese technical high schools in terms of educational content, facilities and instructors.
- In the project classes at DPI, students are making their products under the teachers' guidance within the limited budget. It seems students are acquiring the skills they lack through the project by themselves.

4-2 Idea of the institution; what kind of students do they want to produce

- Raising students who can be operators or provide repair services. Sub-assistant engineer is one of the goals. DPI wants to train programmers and engineers who are capable of web designing.
- DPI wants to develop long-lasting engineers who can improve their own skills based on basic knowledge and practical skills.

4-3 How much matched the students produced by the institution and industrial needs

- It seems that operator is the main job after graduation, but DPI has only limited information on their graduates' job, employment rate, etc.
- There is a gap between industrial human resource needs and graduates because of lack of skills.
- New graduates are treated like amateurs. Although they can be promoted after gaining professional experience, the highest position would be an operator.

4-4 Points that can be used in the industrial society

- Students are highly motivated and if they receive appropriate education and training, DPI students may become important human resources for industry.

5-1 Overall challenges

- It seems hierarchy is formed in private companies, and polytechnic graduates are only doing what they are told to do. If students can acquire ability and custom to think by themselves, they can engage in on-site improvement activities and quality control which lead them to secure position as a mid-level engineer.
- Ability to apply basic knowledge to a real setting is necessary.

5-2 Overall points that can be praised or used in the project

- It is good that the HoDs and instructors who participate in the project are motivated. It'll be the key to keep them highly motivated and improve the mindset for the project.

6-1 Points or idea that KOSEN can apply to

- It still takes time for KOSEN to develop an effective plan to improve technical education for polytechnic institutes. It is better to start from the improvement of experiment and practical classes in which PBL is applied and improve the mindset of instructors little by little. Implementation of 5S (Sort, Set, Shine, Standardize, Sustain) which is applied for workplace environmental improvement also seems to be necessary.
- It seems that there is a challenge of improving practical ability more than theory, so activity using their own hands should be introduced.

Institution Observation Sheet

Date: 2019/07-09

Name of Institution: Dhaka Mohila Polytechnic Institute

1-1 Educational background of instructors

- Model subject instructors: Diploma 18.2%, BSc 63.6%, MSc 9.1%
- 27.3% of instructors obtained BSc from TTTC (equivalent to BSc Engineering degree of DUET)

1-2 Challenges and thoughts towards teaching of instructors

- Unofficial and outdated teaching materials are used, and they need to be updated.
- Instructors have to put emphasis on exam preparation to raise students' grades. Therefore, the classes are crammed in a limited number of hours, rather than giving students time to think for themselves.
- Even for instructors who have no problem with teaching methods, deeper understanding of the essence of subject is needed.

1-3 Challenges and thought towards teaching of practical training

- The number of students is much larger than the number of equipment, so there is little chance of operating equipment during the experiment.
- There is a lack of experience in conducting experiment with their own hands.

1-4 Challenges and thought towards evaluation of practical training

- There is no evaluation system for students to evaluate each other, only a traditional evaluation system such as a paper test.
- The unified exams are directed and conducted by BTEB, so there is a possibility that instructors cannot give their feedback on the exam results to students.

1-5 Thoughts towards instructors' understanding of the subjects

- Deeper understanding of subjects is needed to improve the teaching method of practical training.
- Although instructors have a general understanding their specialty, there is room for further improvement. Many of them responded that they were too busy with conducting daily classes and had no time for self-improvement.
- Instructors can conduct practical classes by using experiment kit, but have difficulties to conduct similar experiment without the kit.

2-1 Situation of facilities

- Although equipment is prepared, the number is still small. There could be seen some measurement devices, but they were put on a floor and might not be used.

- There was a computer room equipped with about 20 PCs. They have internet access but no network server. Construction of network server would be necessary before web designing.
- There is equipment for practical classes and comparatively new ones. The minimum number of equipment to conduct a class covering 40 students is prepared.
- There are some difficulties for instructors to maintain and repair the equipment by themselves because of the lack of knowledge and experience. There are technical staff who can conduct maintenance at KOSEN, and similar staff might be needed for technical institutes in Bangladesh.

2-2 Institution structure and operation

- The institute is managed under DTE, and its approval is very important for organizational decision-making.
- The organization is well structured, but most of the newly requited instructors need to improve their teaching skills.

3-1 Assessment of curriculum and syllabus

- The curriculum is well developed, and the level of content is high. But there can be seen a gap between the level of curriculum and the actual education.

3-2 Assessment of existing teaching material such as manuals and textbooks

- Although computers were equipped, there could be seen no textbook for teaching programming or computer structure.
- Although the textbooks obtained are outdated and not standardized, the contents are sufficient.
- There is no manual for teaching practical classes.

4-1 Level of students out of all Bangladesh students

- Relative comparison is not possible because the level of other educational institutions is not known, but it cannot be said that the level is higher compared with Japanese technical high schools in terms of educational content, facilities and instructors.
- The equipment created by the project class of DMPI won the second prize in the national skill competition which proved that the top-level students are talented.

4-2 Idea of the institution; what kind of students do they want to produce

- Raising students who can be operators or provide repair services. Sub-assistant engineer is one of the goals. DMPI wants to train programmers and engineers who are capable of web designing.
- DMPI wants to develop long-lasting engineers who can improve their own skills based on basic knowledge and practical skills.

4-3 How much matched the students produced by the institution and industrial needs

- There is a gap between industrial human resource needs and graduates because of lack of skills.
- New graduates are treated like amateurs. Although they can be promoted after gaining professional experience, the highest position would be an operator.
- About half of graduates seems to get a job in some form, but most of them will soon get married. It seems that instructors want them to get jobs as engineers and play active roles. Especially IT is a growing industry and it is a relatively easy field for women to participate in.

4-4 Points that can be used in the industrial society

- Students are highly motivated and if they receive appropriate education and training, DMPI students may become important human resources for industry.
- Since IT is a growing industry where women are relatively easy to participate, jobs such as web designing where women can play an active role by using their sensitivity will increase.
- Since DMPI instructors have a quota on the number of MoU with companies per instructor, there are stronger relationships with companies, and more companies that students can be introduced compared to DPI.

5-1 Overall challenges

- It seems hierarchy is formed in private companies, and polytechnic graduates are only doing what they are told to do. If students can acquire ability and custom to think by themselves, they can engage in on-site improvement activities and quality control which lead them to secure position as a mid-level engineer.
- Ability to apply basic knowledge to a real setting is necessary.

5-2 Overall points that can be praised or used in the project

- It is good that the HoDs and instructors who participate in the project are motivated. It'll be the key to keep them highly motivated and improve the mindset for the project. It seems that theory and knowledge are well educated.

6-1 Points or idea that KOSEN can apply to

- It still takes time for KOSEN to develop an effective plan to improve technical education for polytechnic institutes. It is better to start from the improvement of experiment and practical classes in which PBL is applied and improve the mindset of instructors little by little. Implementation of 5S (Sort, Set, Shine, Standardize, Sustain) which is applied for workplace environmental improvement also seems to be necessary.
- It seems that there is a challenge of improving practical ability more than theory, so activity using their own hands should be introduced.

Institution Observation Sheet

Date: 2019/07-09

Name of Institution: Technical Teachers Training College (TTTC)

1-1 Educational background of instructors

- Teachers of TTTC: BSc 78.6%, PhD: 14.3%, Other teachers: MSc
- 35.7% of instructors obtained BSc from TTTC (equivalent to BSc Engineering degree of DUET)

1-2 Challenges and thoughts towards teaching of instructors

- Unofficial and outdated teaching materials are used, and they need to be updated.
- Training for polytechnic teachers is provided. There are about 40 students per class.

1-3 Challenges and thought towards teaching of practical training

- The number of students is much larger than the number of equipment, so there is little chance of operating equipment during the experiment.
- There is a lack of experience in conducting experiment with their own hands.

1-4 Challenges and thought towards evaluation of practical training

- There is no evaluation system for students to evaluate each other, only a traditional evaluation system such as a paper test.

1-5 Thoughts towards instructors' understanding of the subjects

- Deeper understanding of subjects is needed to improve the teaching method of practical training.
- Although instructors have a general understanding of their specialty, there is room for further improvement. It seems they have no intention to make the experimental equipment by themselves.
- Instructors can conduct practical classes by using experiment kit, but have difficulties to conduct similar experiment without the kit.
- In Electronics technology, there seems to be a problem with the ability to read wiring and circuit diagrams.

2-1 Situation of facilities

- In the Mechanical technology, there are machine tools but they are outdated and number is not enough.
- There are also measuring devices, but they are placed on the floor where things are not well-organized, and it is not sure that the devices are actually used.
- In the Computer technology, there is a room with about 20 PCs. Internet is available but there is no server.

- There were old and new electrical and electronics experimental devices. However, the number of devices is too small compared to the number of students.
- There are two rooms with about 20 PCs. Although the PCs are connected to the internet, there is no network server and it is difficult to consider how to conduct web design practice.
- There are training equipment and also relatively new equipment. The minimum number of equipment for 40 students per class is prepared. The latest equipment has been introduced by the World Bank, but teachers are not making full use of it.
- There are some difficulties for instructors to maintain and repair the equipment by themselves because of the lack of knowledge and experience. There are technical staff who can conduct maintenance at KOSEN, and similar staff might be needed for technical institutes in Bangladesh.

2-2 Institution structure and operation

- The institute is managed under DTE, and its approval is very important for organizational decision-making.
- The organization is well structured, but most of the newly requited instructors need to improve their teaching skills.

3-1 Assessment of curriculum and syllabus

- TTTC’s curriculum was not available.

3-2 Assessment of existing teaching material such as manuals and textbooks

- For Mechanical technology, textbooks were not available.
- For Computer technology, any teaching materials that teach programming or the structure of a computer were found. It’d be better to have a poster showing the structure of the computer in the classroom.
- The content of textbooks obtained are sufficient, although they are outdated and not standardized.
- There is no manual for teaching practical classes.

4-1 Level of students out of all Bangladesh students

- Relative comparison is not possible because the level of other educational institutions is not known, but it cannot be said that the level is higher compared with Japanese technical high schools in terms of educational content, facilities and instructors.

4-2 Idea of the institution; what kind of students do they want to produce

- Trainers who can train engineers with programming and web designing skills.
- TTTC wants to develop long-lasting engineers who can improve their own skills based on basic knowledge and practical skills.

4-3 How much matched the students produced by the institution and industrial needs

- N/A

4-4 Points that can be used in the industrial society

- N/A

5-1 Overall challenges

- If teachers can acquire ability and custom to think by themselves, they can engage in on-site improvement activities and quality control which lead them to secure position as a mid-level engineer.
- In the Electrical and Electronics technologies, there is a challenge that teachers cannot handle experiment without using the given training kit. Ability to apply basic knowledge to a real setting is necessary.
- A hierarchy is formed in the society of Bangladesh, or its influence remains strong. It will be tough work to overcome this habit. Although it will take long time to change the mindset, it seems to be the biggest challenge for the future.

5-2 Overall points that can be praised or used in the project

- It is good that the HoDs and instructors who participate in the project are motivated. It'll be the key to keep them highly motivated and improve the mindset for the project.
- Theory and knowledge seem to be well educated.

6-1 Points or idea that KOSEN can apply to

- It still takes time for KOSEN to develop an effective plan to improve technical education for polytechnic institutes. It is better to start from the improvement of experiment and practical classes in which PBL is applied and improve the mindset of instructors little by little. Implementation of 5S (Sort, Set, Shine, Standardize, Sustain) which is applied for workplace environmental improvement also seems to be necessary.
- It seems that there is a challenge of improving practical ability more than theory, so activity using their own hands should be introduced.

Result of skill list assessment for the teachers of DPI

Project target for achievement is **level 4**.

Point		Level1	Level2	Level3	Level4	Level5	Avarage Level
Standard of each level		Not yet achieved at all	Partially problem but acceptable	No problem	With student's initiative	Can be applied in a company or society	
Class design							
1	**Achievement goal in practical training**	Teacher did not state the achievement goal of practical training.	Teacher stated the goal in the practical training but it had little relation with the goal of the unit, or too general or abstract.	Teacher described the practical training goal related to the achievement goals of the unit.			2.50
2	**Practical training design**	Teacher did not design the practical training.	Teacher designed the practical training, but it had little relation with the goal of the unit.	Teacher designed practical training which had relation with the goals of the unit.	Teacher designed the practical training which had relation with the goals of the unit and lead students' active involvement to the practical training.	In addition to level4, the practical training was designed to lead students to find principle.	2.33
3	**Preparation of equipment for the practical training**	Equipment to be used in practical training was not prepared.	Some of the equipment for the practical training was prepared, but not all.	All the equipment for the practical training was prepared.			2.50
4	**Preparation of materials to explain practical training**	Materials to explain practical training were not prepared.	Materials to explain practical training were prepared, but what to learn and what to do in the practical training were unclear.	Materials were prepared, which described what to learn and what to do in the practical training.	Materials were prepared, which described what to learn and what to do in the practical training. Besides, it led students' active learning.	In addition to level4, materials included examples of industrial applications.	2.25
Teaching method							
5	**Activity of the class**	Teacher introduced activities that did not meet the goals of practical training or did not help students' understanding.	Teacher partially introduced activities related to the goal of practical training, or activities that promoted student understanding.	Teacher introduced activities related to the goal of practical training and the activities promoted students' understanding.	Teacher introduced activities related to the goal of practical training, and introduced a system which led students to participate voluntarily.	In addition to level4, teacher introduced activities that allowed students to learn by trial and error and students could realize the knowledge they have learned in the training.	2.43
6	**Technical knowledge level**	Teacher does not have knowledge of the practical training.	Teacher have technical knowledge of practical training but not enough.	Teacher have basic technical knowledge of practical training.	Teacher have enough technical knowledge to answer the student's question properly.	Teacher have enough technical knowledge to teach how to solve the social problems for students.	2.50
7	**Difficulty of the class**	The class content was difficult and not understandable for most students.	The class content could be understood without difficulty for more than half of the students.	The class content was not too difficult and understandable for most students.			2.25
8	**Question skill**	Teacher did not ask the students.	Teacher asked questions that could be answered with "Yes" or "No".	Teachers asked students for answers.	Teacher asked questions that encourage students to discuss each other.	Teachers ask questions that encourage students to discuss social issues.	2.38
9	**Students' participation to the practical training**	Teacher continued to explain unilaterally, and conducted practical training by only him/herself.	Teacher explained practical training and asked students to participate in the practical training but it was difficult for the students to do by their own because of lack of teacher's explanation.	Teacher explained the practical training and students could practice by their own.	Teacher gave explanations of the practical training to attract the students' attention, and the students conducted the practical training, realizing what is necessary to solve the problem.	In addition to level4, students could evaluate necessary practical training plan and validity of the analysis, and design practical training plan again.	2.63
10	**Introducing collaboration work**	Teacher did not introduce activities that allowed students to work together.	Teacher partially introduced activities that allowed students to work together.	Teacher introduced activities that allowed students to work together.	Teacher introduced activities that allowed students to work together and the students facilitated the work by themselves.	In addition to level4, students could find problems or achievement by themselves through the work. Ex) Students could image what they have learned through words and drawn pictured.	2.00
11	**Language**	Teacher conducted the class in a language that students could not understand.	Teacher conducted the class in a language that more than half of the students could understand.	Teacher conducted the class in a language that most students could understand.			2.75
12	**Safety instruction**	Teacher did not give safety instruction of the equipment used in the practical training.	Teacher partially gave safety instruction of the equipment used in the practical training.	Teacher clearly gave safety instruction of the equipment used in the practical training.			1.60

13	**Feedback to students**	Teacher did not give feedback to students.	Teacher gave feedback to the students but only told them "correct" or "wrong".	Teacher provided feedback that encourages students to better understand.	Teacher provided feedback that encourages further understanding of students, and facilitated students to exchange their feedbacks among students. It encouraged students to realize what they could and could not.	In addition to level4, students could realize their situation through metacognition.	2.38
14	**Analysis and discussion of the practical training**	Teacher did not review the result of practical training.	Teacher made students review, analyze and discuss the result of the practical training, using teacher's format.	Teacher instructed students to summarize the result of practical training and analyze and discuss.	In addition to level3, teacher encouraged students to analyze and discuss logically based on the result of practical training.	Teacher encouraged students to analyze and discuss logically from various perspectives based on the result of practical training. Besides, students could evaluate its validity.	2.25
Class management							
15	**Class control**	Students acted as they liked, without following the teacher's instructions.	Some students acted as they liked without following the teacher's instructions.	Students acted following the instruction of the teacher.	Students understood teacher's instruction and made effort to complete the instruction.	Students understood teacher's instruction and made effort and support to complete the instruction as a class.	2.88
16	**Time management**	Teacher could not complete the practical training within the acceptable time, or ended too early.	Teacher could complete the practical training but it exceeded the time or ended early with the allowable range.	Teacher could complete the practical training within the time.			2.50

※ Evaluate the items related to Active Learning and Project-Based Learning (items related to student proactive action and ability to be used in society and companies) in 5 levels.

※ Items up to level 5 are scored from 1 to 5 points, and items up to level 3 are scored at 1 point for level 1, 3 points for level 2 and 5 points for level 3.

※Model subjects are taught one term a year and monitoring of model subject is conducted once a year. On the other hand, monitoring to evaluate teacher's skill is conducted once a 6 months.

Result of skill list assessment for the teachers of DMPI

Project target for achievement is **level 4**.

Point		Level1	Level2	Level3	Level4	Level5	Avarage Score
Standard of each level		**Not yet achieved at all**	**Partially problem but acceptable**	**No problem**	**With student's initiative**	**Can be applied in a company or society**	
Class design							
1	**Achievement goal in practical training**	Teacher did not state the achievement goal of practical training.	Teacher stated the goal in the practical training but it had little relation with the goal of the unit, or too general or abstract.	Teacher described the practical training goal related to the achievement goals of the unit.			3.00
2	**Practical training design**	Teacher did not design the practical training.	Teacher designed the practical training, but it had little relation with the goal of the unit.	Teacher designed practical training which had relation with the goals of the unit.	Teacher designed the practical training which had relation with the goals of the unit and lead students' active involvement to the practical training.	In addition to level4, the practical training was designed to lead students to find principle.	3.00
3	**Preparation of equipment for the practical training**	Equipment to be used in practical training was not prepared.	Some of the equipment for the practical training was prepared, but not all.	All the equipment for the practical training was prepared.			3.00
4	**Preparation of materials to explain practical training**	Materials to explain practical training were not prepared.	Materials to explain practical training were prepared, but what to learn and what to do in the practical training were unclear.	Materials were prepared, which described what to learn and what to do in the practical training.	Materials were prepared, which described what to learn and what to do in the practical training. Besides, it led students' active learning.	In addition to level4, materials included examples of industrial applications.	2.50
Teaching method							
5	**Activity of the class**	Teacher introduced activities that did not meet the goals of practical training or did not help students' understanding.	Teacher partially introduced activities related to the goal of practical training, or activities that promoted student understanding.	Teacher introduced activities related to the goal of practical training and the activities promoted students' understanding.	Teacher introduced activities related to the goal of practical training, and introduced a system which led students to participate voluntarily.	In addition to level4, teacher introduced activities that allowed students to learn by trial and error and students could realize the knowledge they have learned in the training.	2.00
6	**Technical knowledge level**	Teacher does not have knowledge of the practical training.	Teacher have technical knowledge of practical training but not enough.	Teacher have basic technical knowledge of practical training.	Teacher have enough technical knowledge to answer the student's question properly.	Teacher have enough technical knowledge to teach how to solve the social problems for students.	2.50
7	**Difficulty of the class**	The class content was difficult and not understandable for most students.	The class content could be understood without difficulty for more than half of the students.	The class content was not too difficult and understandable for most students.			2.75
8	**Question skill**	Teacher did not ask the students.	Teacher asked questions that could be answered with "Yes" or "No".	Teachers asked students for answers.	Teacher asked questions that encourage students to discuss each other.	Teachers ask questions that encourage students to discuss social issues.	3.00
9	**Students' participation to the practical training**	Teacher continued to explain unilaterally, and conducted practical training by only him/herself.	Teacher explained practical training and asked students to participate in the practical training but it was difficult for the students to do by their own because of lack of teacher's explanation.	Teacher explained the practical training and students could practice by their own.	Teacher gave explanations of the practical training to attract the students' attention, and the students conducted the practical training, realizing what is necessary to solve the problem.	In addition to level4, students could evaluate necessary practical training plan and validity of the analysis, and design practical training plan again.	2.75
10	**Introducing collaboration work**	Teacher did not introduce activities that allowed students to work together.	Teacher partially introduced activities that allowed students to work together.	Teacher introduced activities that allowed students to work together.	Teacher introduced activities that allowed students to work together and the students facilitated the work by themselves.	In addition to level4, students could find problems or achievement by themselves through the work. Ex) Students could image what they have learned through words and drawn pictured.	1.50
11	**Language**	Teacher conducted the class in a language that students could not understand.	Teacher conducted the class in a language that more than half of the students could understand.	Teacher conducted the class in a language that most students could understand.			3.00
12	**Safety instruction**	Teacher did not give safety instruction of the equipment used in the practical training.	Teacher partially gave safety instruction of the equipment used in the practical training.	Teacher clearly gave safety instruction of the equipment used in the practical training.			2.00

13	**Feedback to students**	Teacher did not give feedback to students.	Teacher gave feedback to the students but only told them "correct" or "wrong".	Teacher provided feedback that encourages students to better understand.	Teacher provided feedback that encourages further understanding of students, and facilitated students to exchange their feedbacks among students. It encouraged students to realize what they could and could not.	In addition to level4, students could realize their situation through metacognition.	3.00
14	**Analysis and discussion of the practical training**	Teacher did not review the result of practical training.	Teacher made students review, analyze and discuss the result of the practical training, using teacher's format.	Teacher instructed students to summarize the result of practical training and analyze and discuss.	In addition to level3, teacher encouraged students to analyze and discuss logically based on the result of practical training.	Teacher encouraged students to analyze and discuss logically from various perspectives based on the result of practical training. Besides, students could evaluate its validity.	2.00
Class management							
15	**Class control**	Students acted as they liked, without following the teacher's instructions.	Some students acted as they liked without following the teacher's instructions.	Students acted following the instruction of the teacher.	Students understood teacher's instruction and made effort to complete the instruction.	Students understood teacher's instruction and made effort and support to complete the instruction as a class.	3.00
16	**Time management**	Teacher could not complete the practical training within the acceptable time, or ended too early.	Teacher could complete the practical training but it exceeded the time or ended early with the allowable range.	Teacher could complete the practical training within the time.			2.75

※ Evaluate the items related to Active Learning and Project-Based Learning (items related to student proactive action and ability to be used in

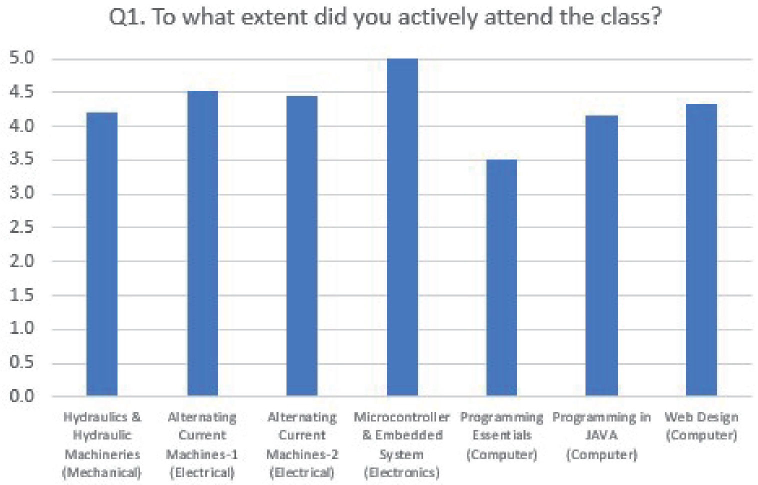
※ Items up to level 5 are scored from 1 to 5 points, and items up to level 3 are scored at 1 point for level 1, 3 points for level 2 and 5 points for level 3.

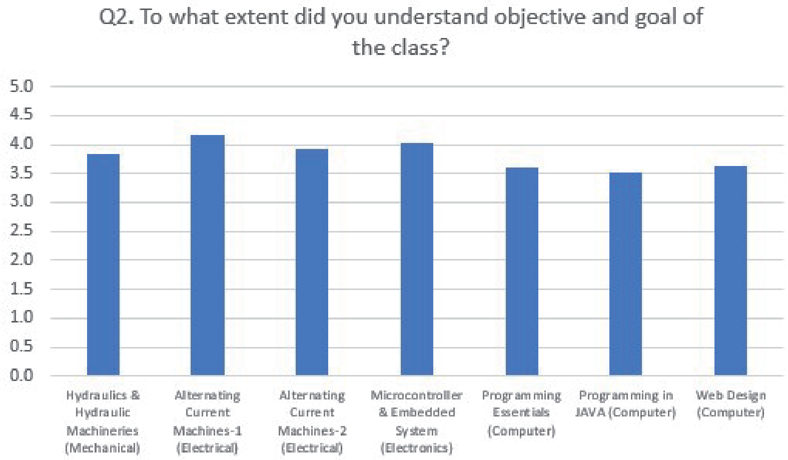
※Model subjects are taught one term a year and monitoring of model subject is conducted once a year. On the other hand, monitoring to evaluate teacher's skill is conducted once a 6 months.

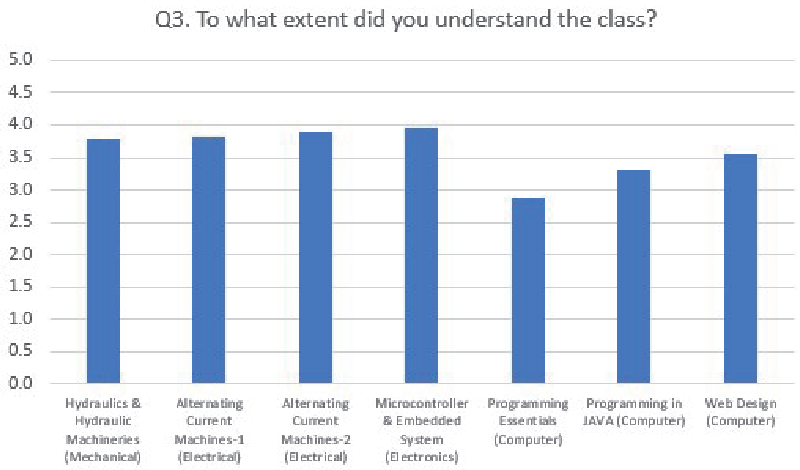
Result of the model subject survey (DPI)

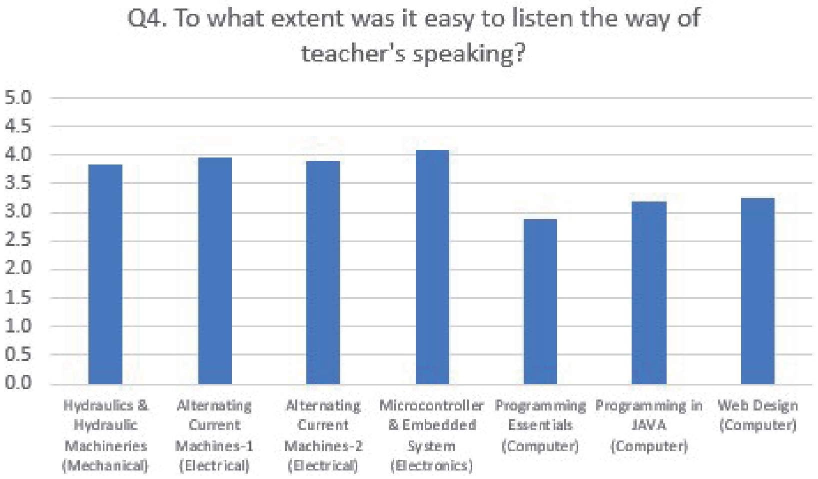
Taken in July 2019

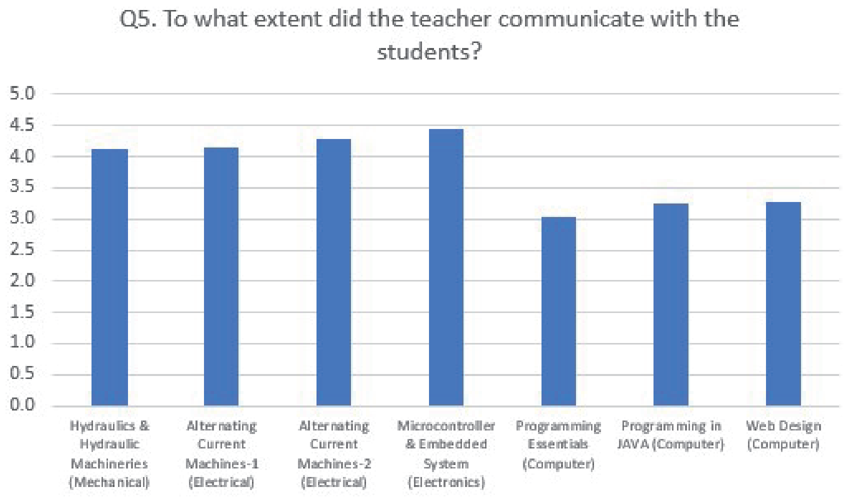
All the 8th semester students answered their satisfaction level for the following questions on a five-point scale (1: Lowest, 5: Highest)

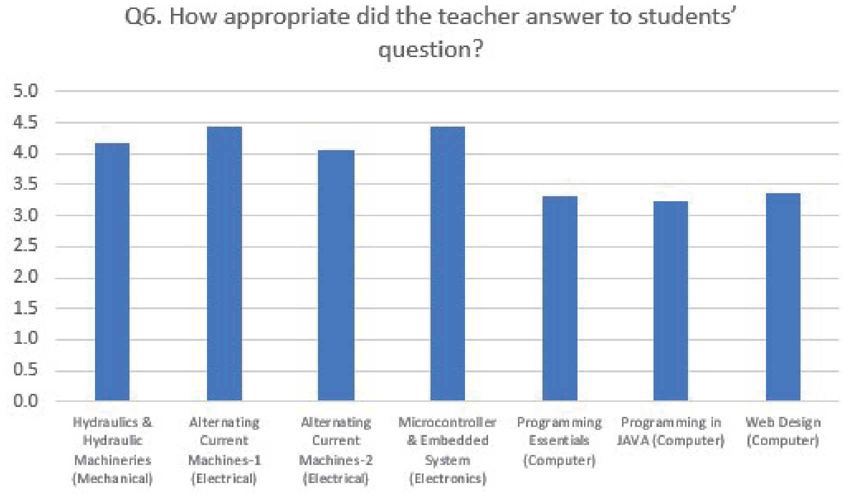

Q1. To what extent did you actively attend the class?

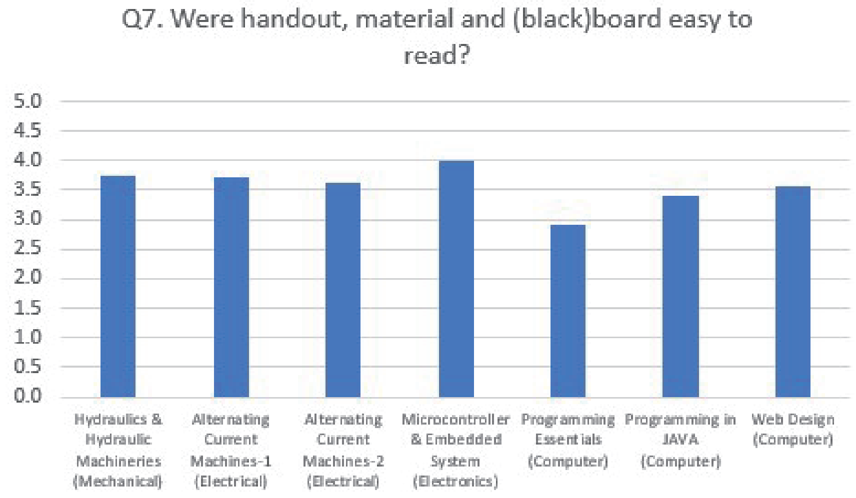

Q2. To what extent did you understand objective and goal of the class?

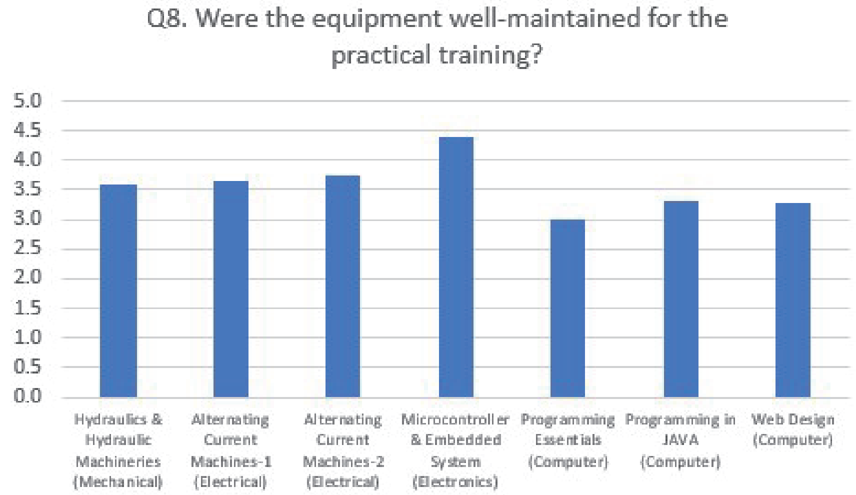

Q3. To what extent did you understand the class?

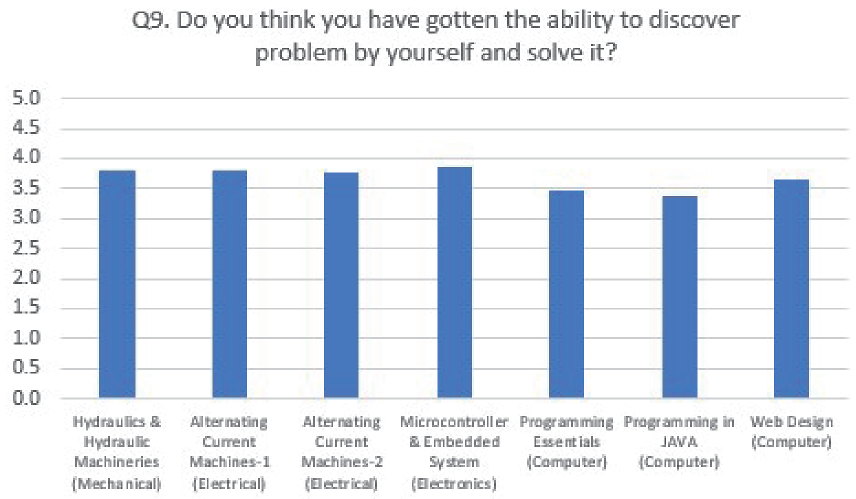

Q4. To what extent was it easy to listen the way of teacher's speaking?


Q5. To what extent did the teacher communicate with the students?

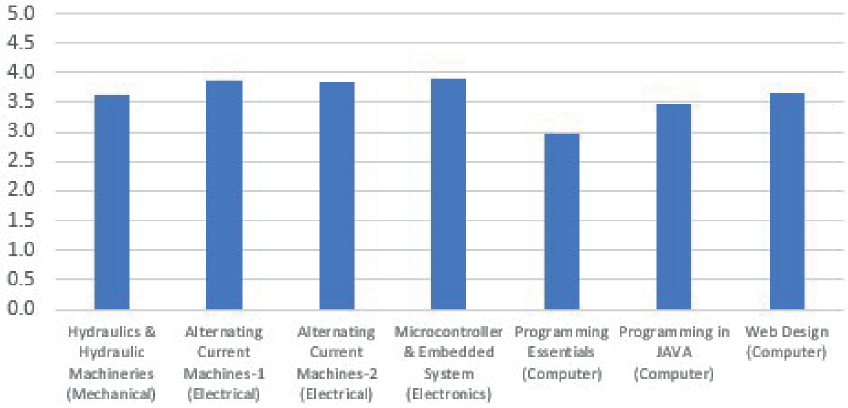

Q6. How appropriate did the teacher answer to students' question?


Q7. Were handout, material and (black)board easy to read?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Hydraulics & Hydraulic Machineries (Mechanical)
Alternating Current Machines-1 (Electrical)
Alternating Current Machines-2 (Electrical)
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)

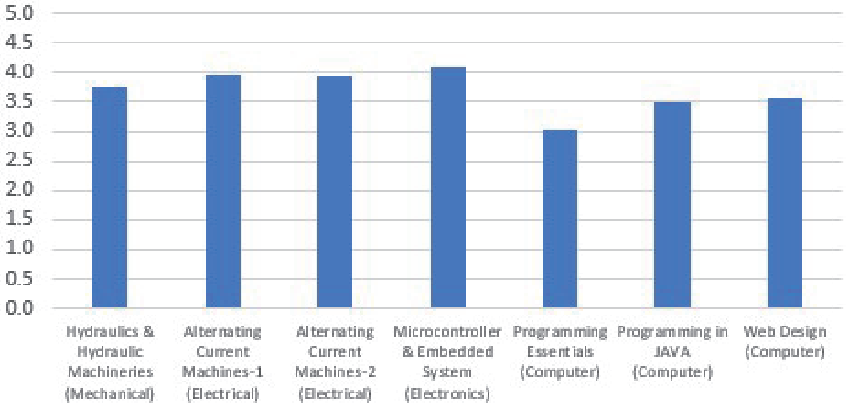

Q8. Were the equipment well-maintained for the practical training?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Hydraulics & Hydraulic Machineries (Mechanical)
Alternating Current Machines-1 (Electrical)
Alternating Current Machines-2 (Electrical)
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)


Q9. Do you think you have gotten the ability to discover problem by yourself and solve it?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Hydraulics & Hydraulic Machineries (Mechanical)
Alternating Current Machines-1 (Electrical)
Alternating Current Machines-2 (Electrical)
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)

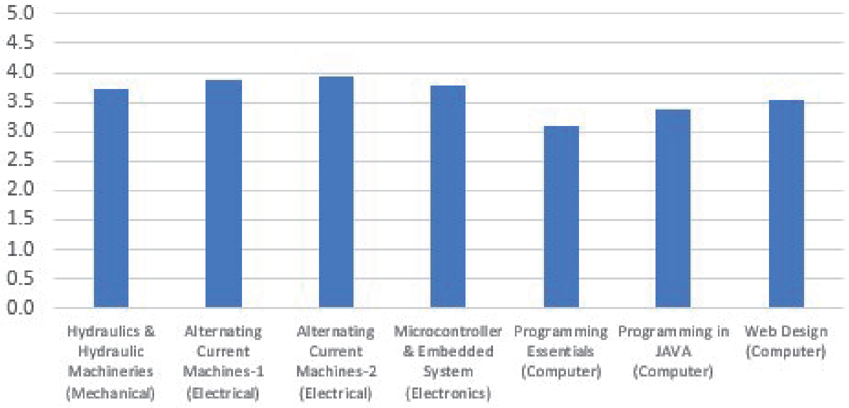
Q10. Do you think you have gotten the ability to think critically?



Q11. Do you think you have gotten the communication ability to discuss, present and cooperate with others?



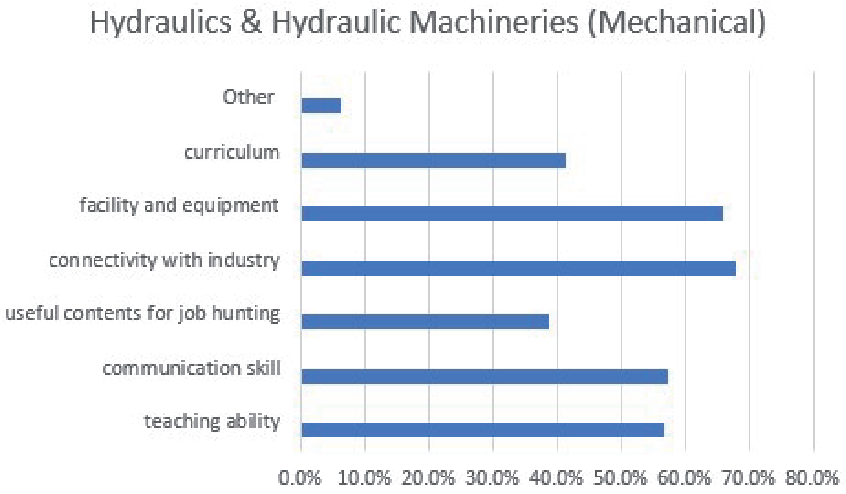
Q12. Do you think your capacity and technique to use equipment have been improved?

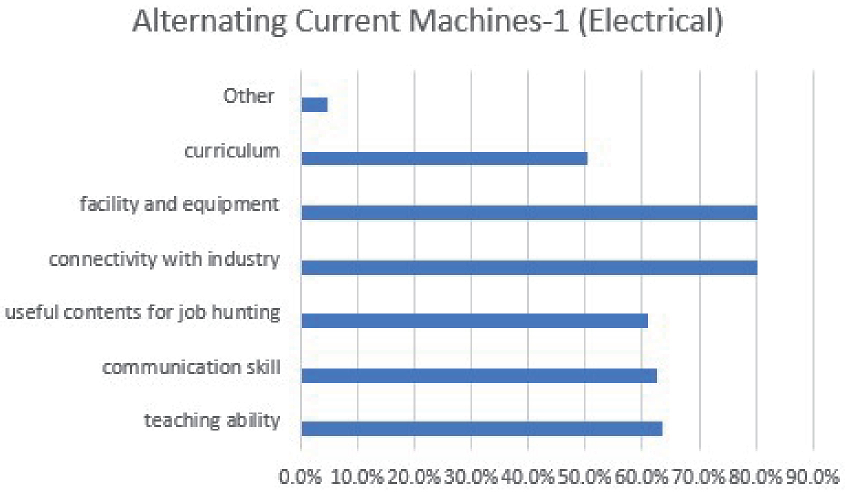


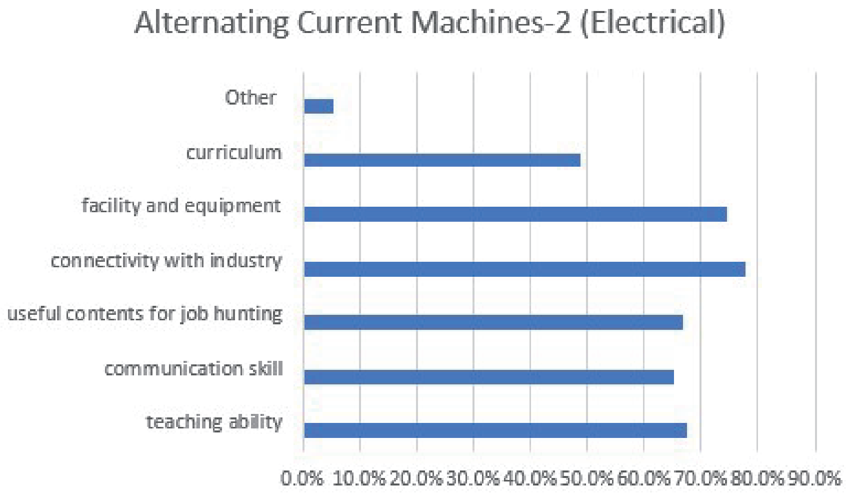
Discussion

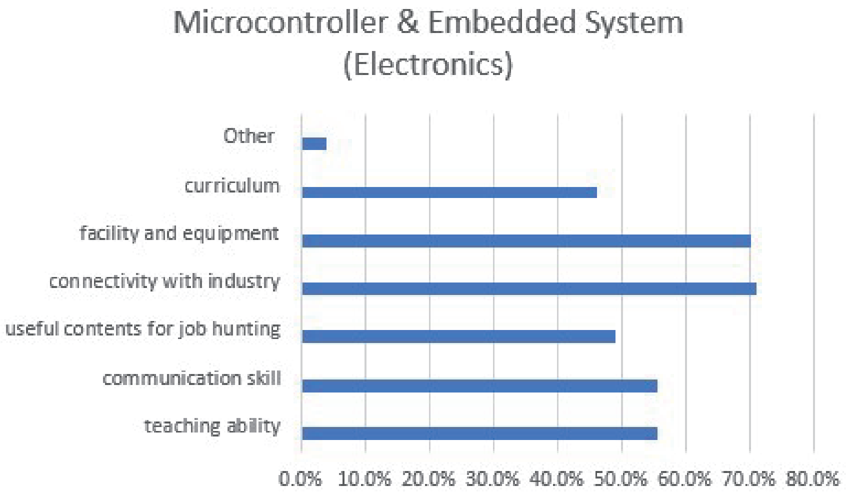
Comparing to Mechanical, Electrical and Electronics subjects, Computer subjects tend to get lower satisfaction, especially, Programming Essentials (Computer). It is necessary to know the reasons. One of the possibilities based on the observation is that teachers teach the subject unilaterally to the students. Besides, they teach just the codes and do not teach how to apply the coding. So this JICA project concept can be highly applied to the classes to improve the classes.

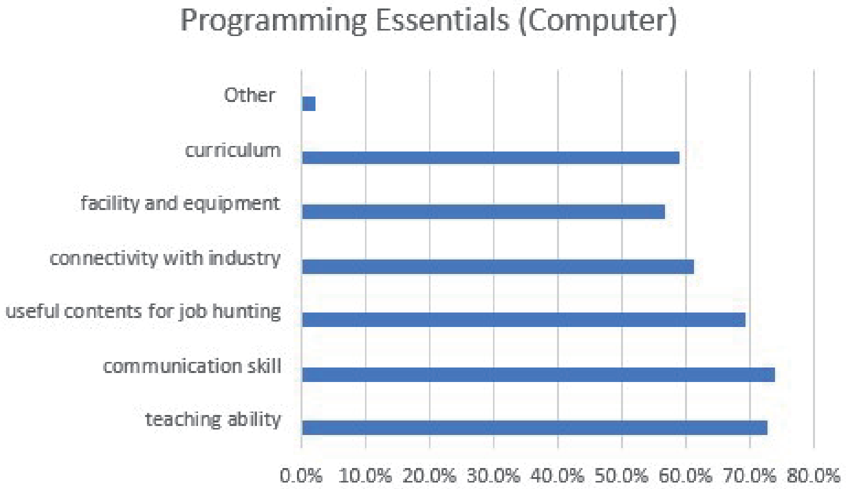
Q14. What are necessary to improve the class? (Select all that apply)

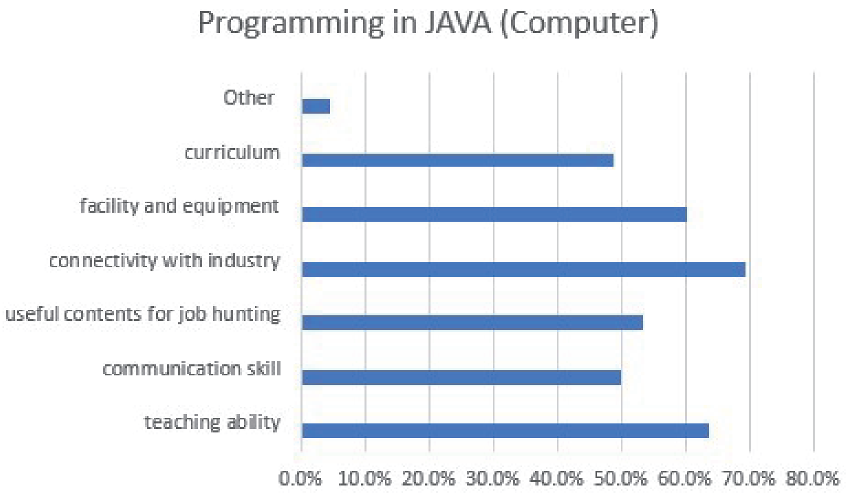


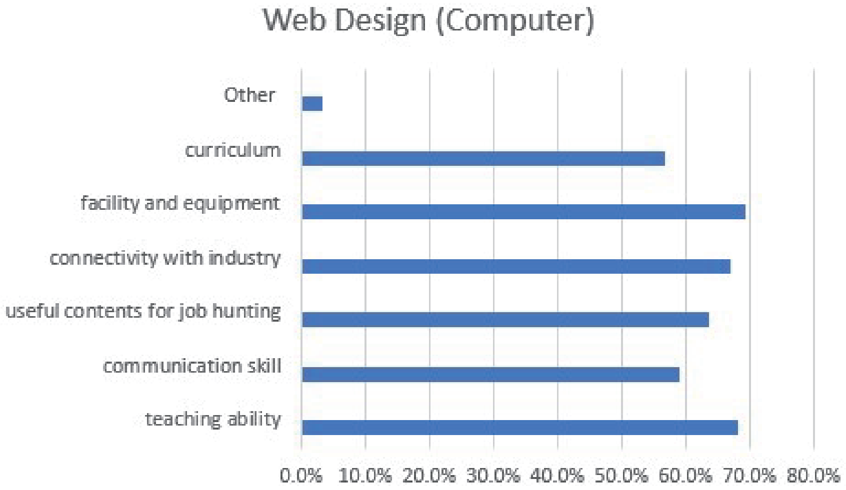



Alternating Current Machines-2 (Electrical)


Microcontroller & Embedded System (Electronics)

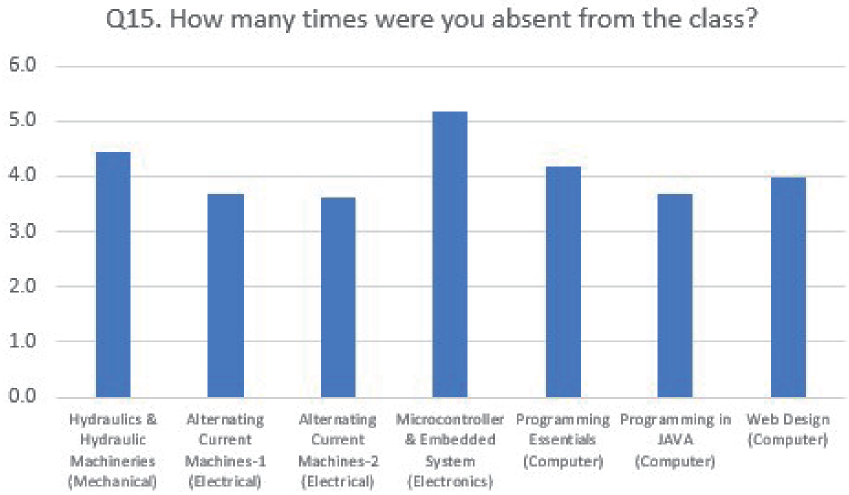

Programming Essentials (Computer)





Discussion

Most Mechanical, Electrical and Electronics students request to improve facilities and equipments and strengthen connectivity with industry. More students of computer request to develop teacher's comunication skill and teaching ability. Computer class is less necessary to use facilities and equipments but teacher's ability might be lower than other subjects teachers.



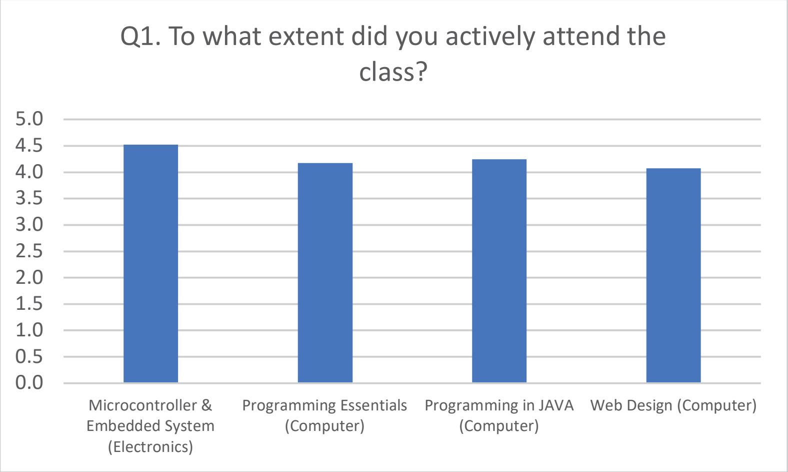
<u>Discussion</u>

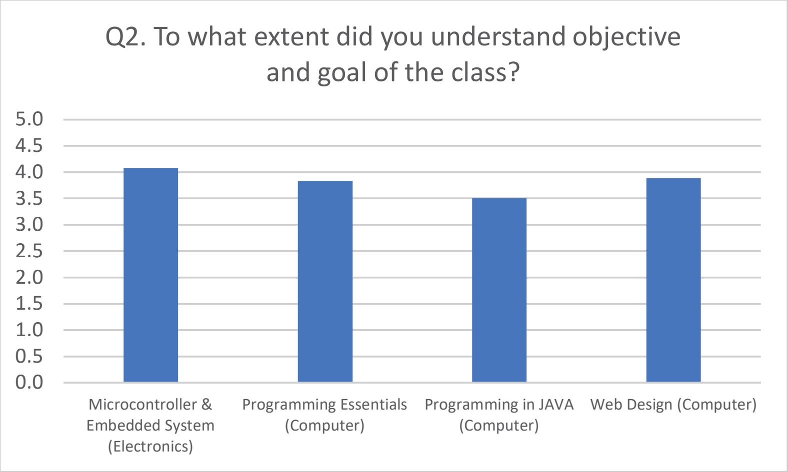
Microcontroller & Embedded System (Electronics) got highest satisfaction through most of the question, however, students were absent the class most at the same time. It might be because the class was easy to understand, and students could be absent easily?

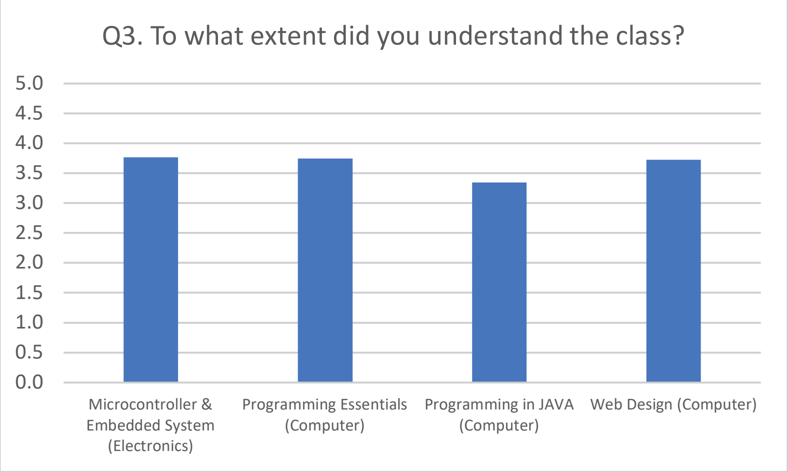
Result of the model subject survey (DMPI)

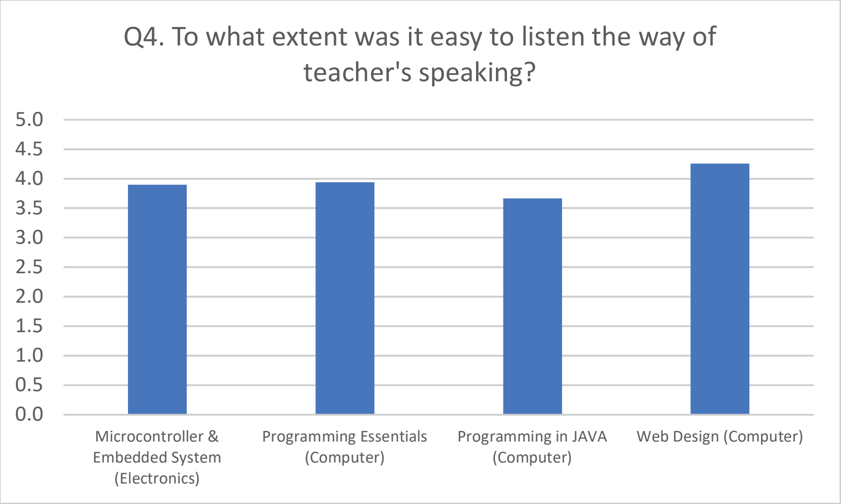
Taken in July 2019

All the 8th semester students answered their satisfaction level for the following questions on a five-point scale (1: Lowest, 5: Highest)

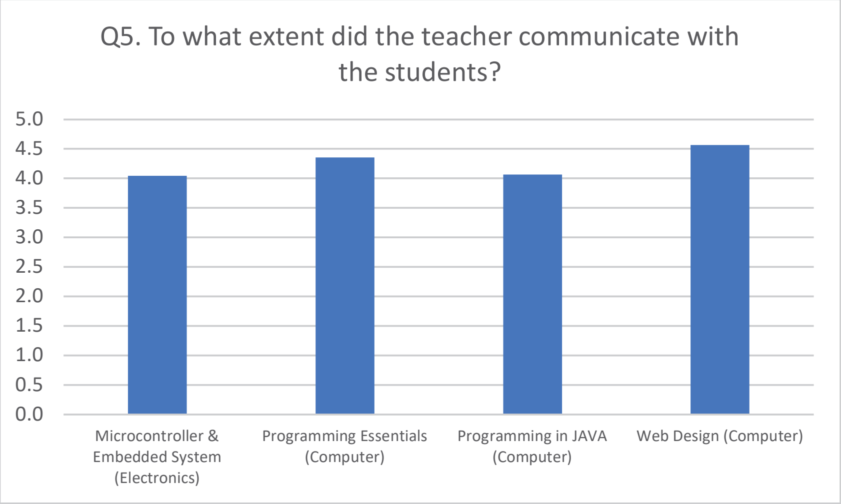




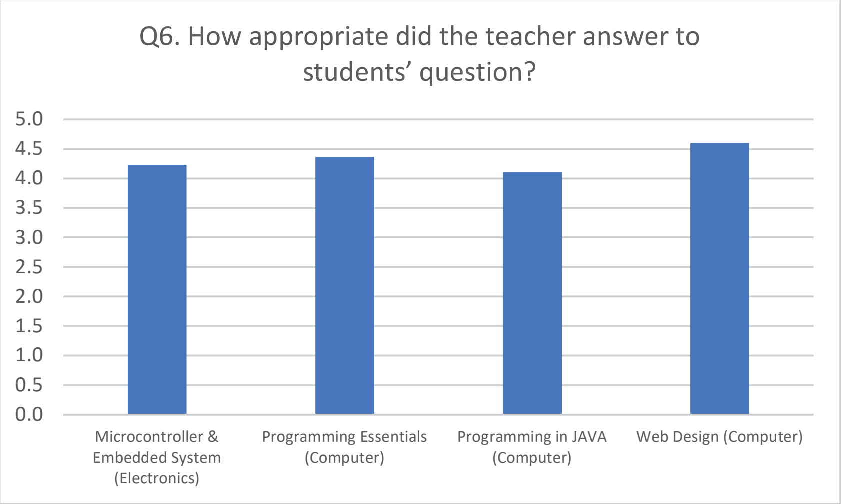




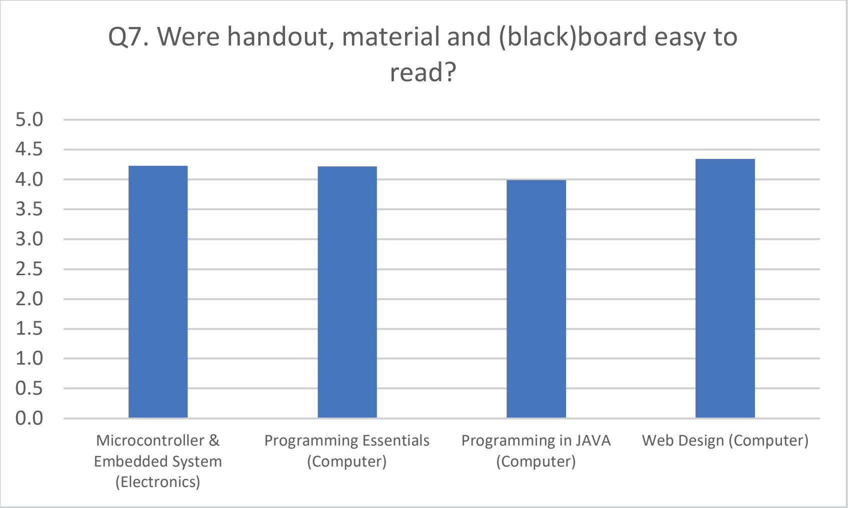
Q4. To what extent was it easy to listen the way of teacher's speaking?

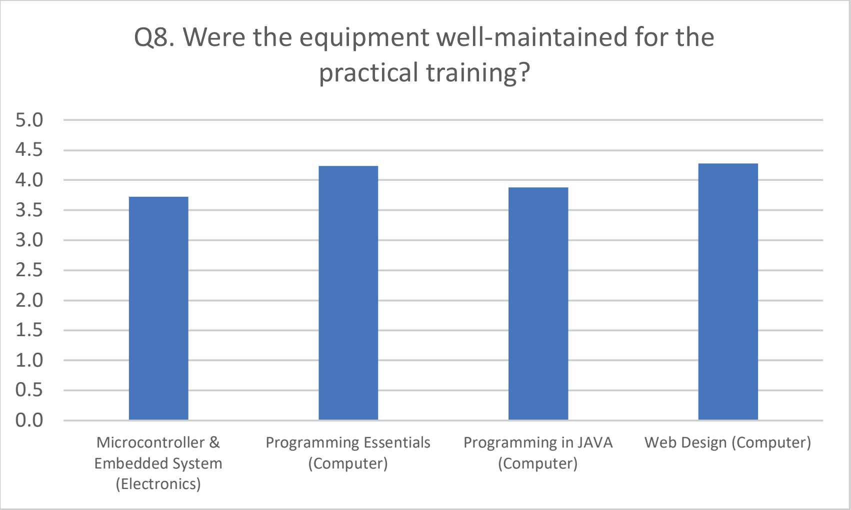


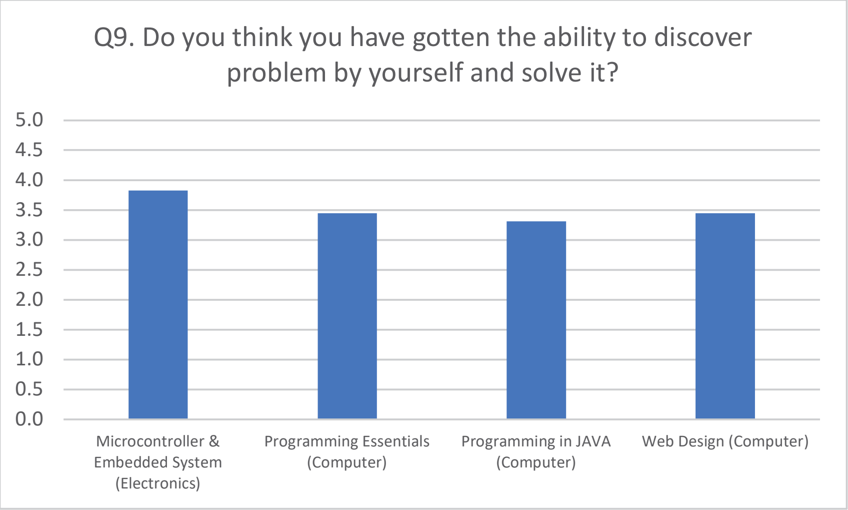
Q5. To what extent did the teacher communicate with the students?

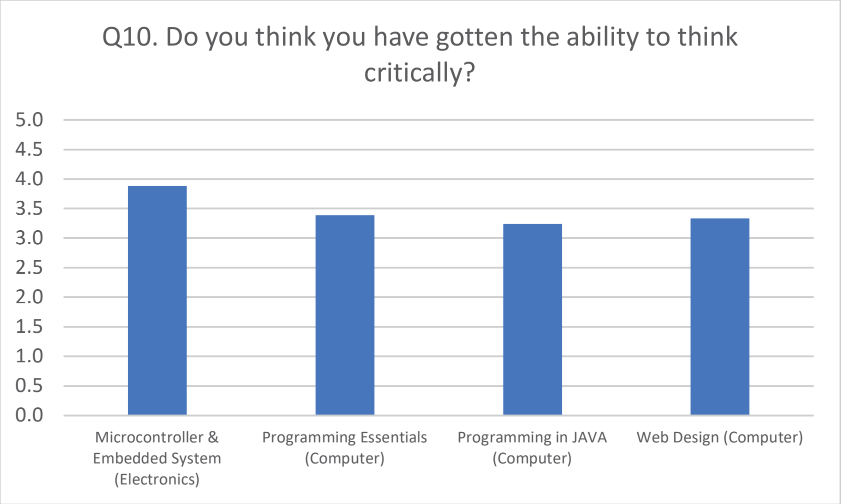


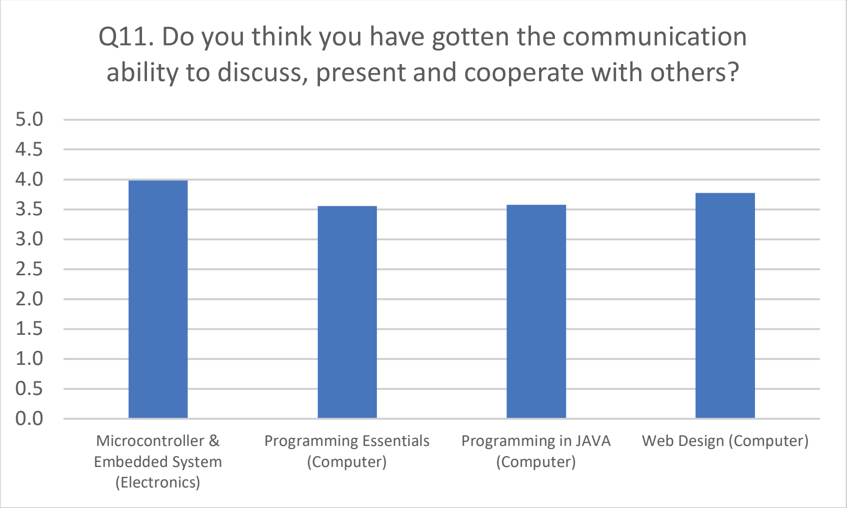
Q6. How appropriate did the teacher answer to students' question?

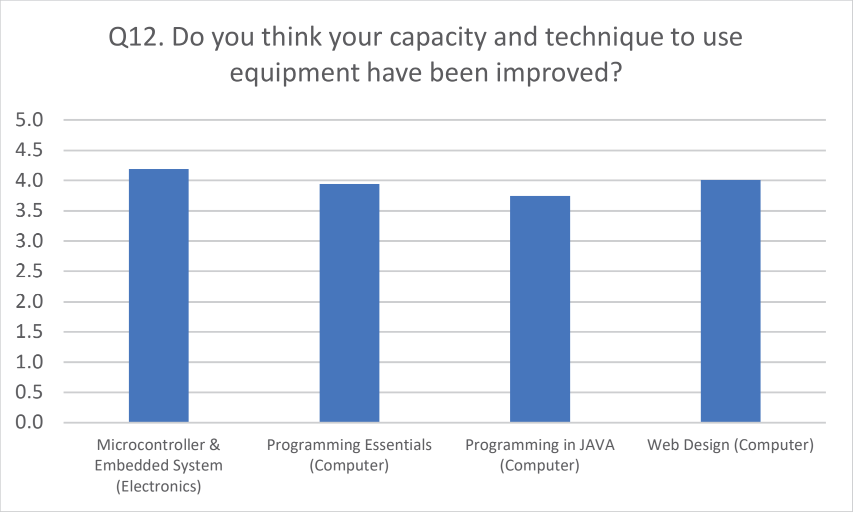

Q7. Were handout, material and (black)board easy to read?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)


Q8. Were the equipment well-maintained for the practical training?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)


Q9. Do you think you have gotten the ability to discover problem by yourself and solve it?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Microcontroller & Embedded System (Electronics)
Programming Essentials (Computer)
Programming in JAVA (Computer)
Web Design (Computer)





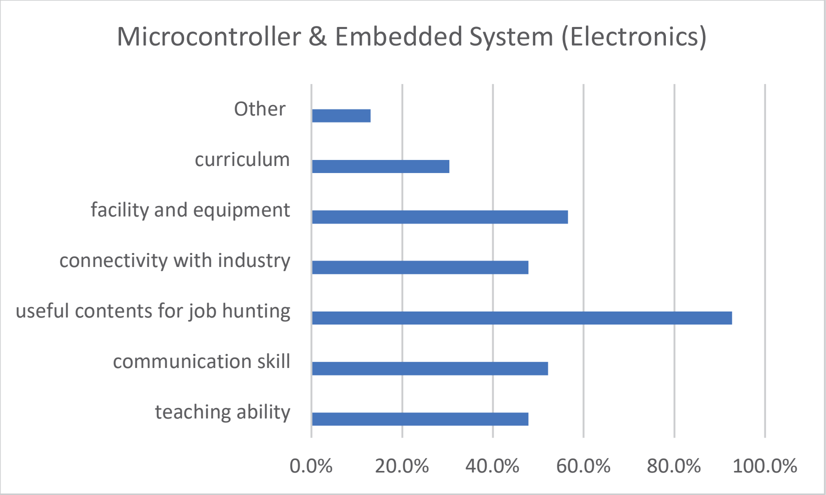


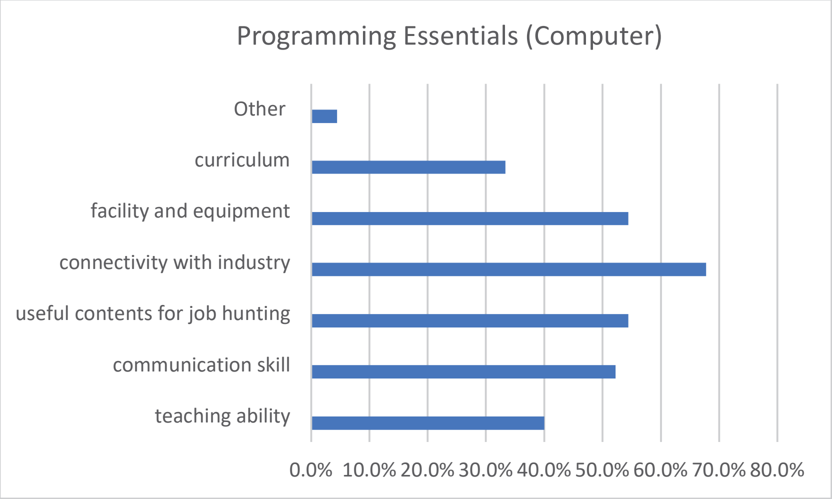
<u>Discussion</u>

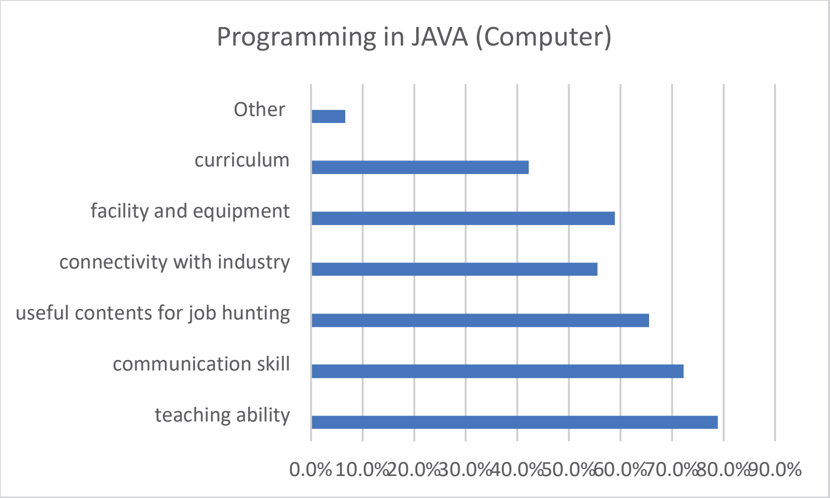
Comparing to DPI, DMPI has less satisfaction difference between subjects. Although, “Q9. Do you think you have gotten the ability to discover problem by yourself and solve it?” and “Q10. Do you think you have gotten the ability to think critically?" are wholly lower than other questions and it means DMPI needs active learning.

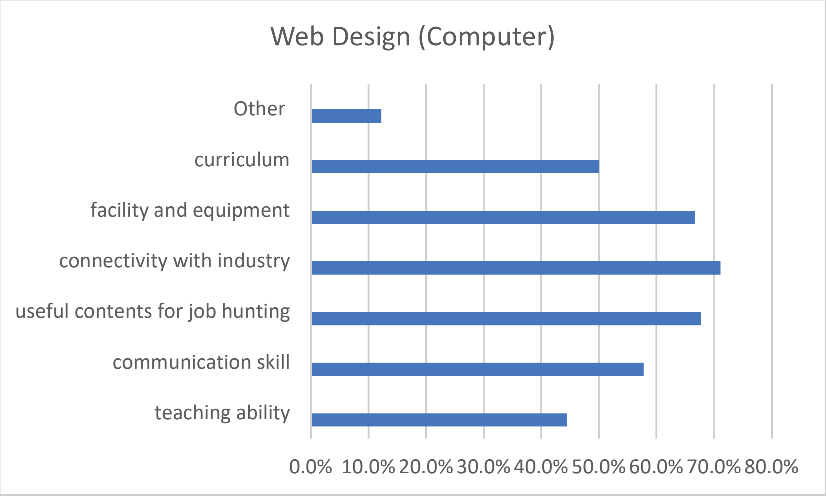
DPI's programming Essential (Computer) was the lowest satiation subject however, DMPI's same subject got not bad satisfaction. Thus, DPI's lower satisfaction might not stem from subject difficulty but from teacher or class some reasons.

Q14. What are necessary to improve the class? (Select all that apply)



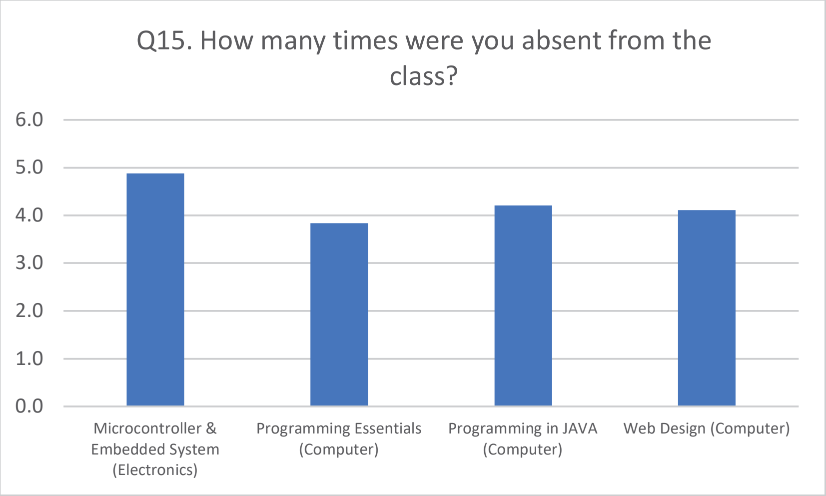






Discussion

Comparing to DPI, DMPI needs more job-related things; connectivity with industry and useful contents for job hunting. It might be related to character of the school, girl's school and it is clear to see in the description question, students are eager to have chance to get their jobs.



<u>Discussion</u>

Same as DPI, higher satisfaction level the subject gets, lower attendance it seems. It is necessary to know the reason.

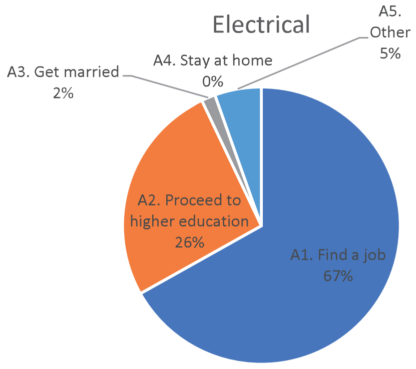
Result of Pre-graduation Survey of 8th semester's students on Job Placement in 2019

Dhaka Polytechnic Institute (DPI)

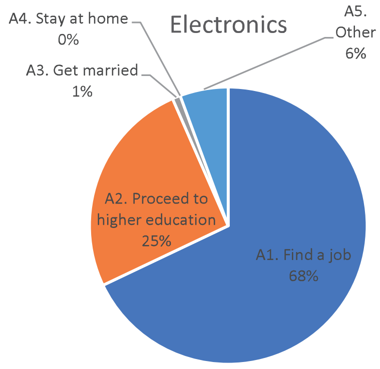
Number of Respondents

Technology	Male	Female	Total
Electrical	160 (87%)	24 (13%)	184
Electronics	89 (84%)	17 (16%)	106
Mechanical	159 (85%)	27 (15%)	186
Computer	71 (81%)	17 (19%)	88
Total	479 (85%)	85 (15%)	564

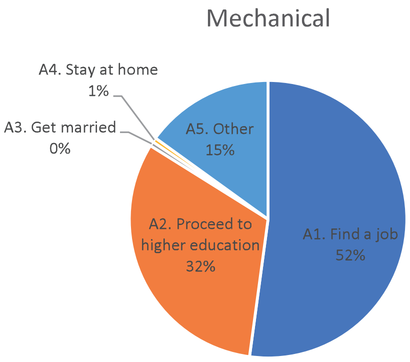
Q1. What is your preferred career path after graduation? (Select only one)



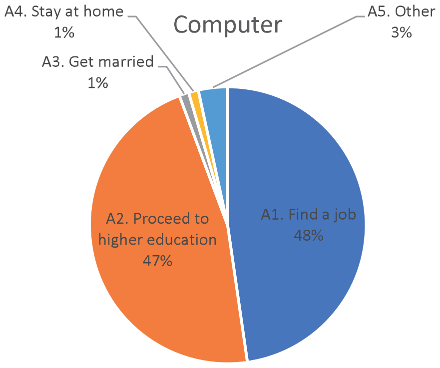
Other: Both A1 & A2, Go abroad



Other: Both A1 & A2, Business

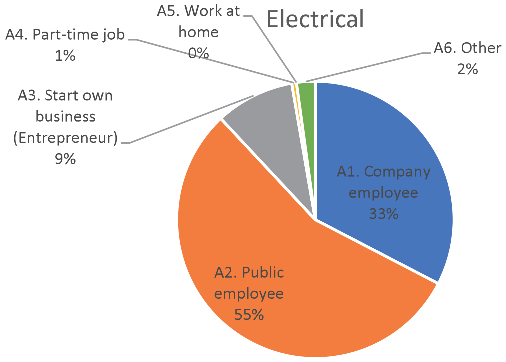


Other: Both A1 & A2, Training, Business, etc.

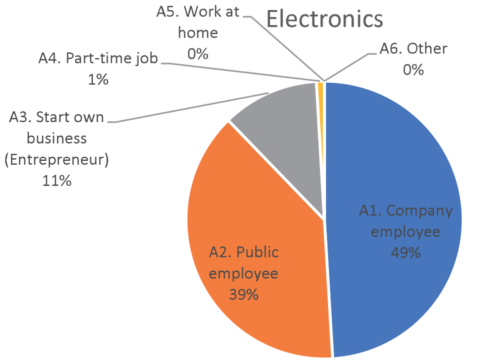


Other: Both A1 & A2

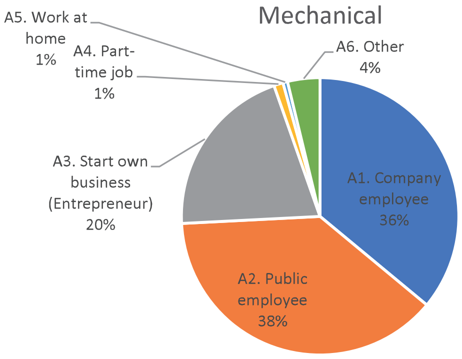
Q2. If you want to find a job, what types of job do you want? (Select only one)



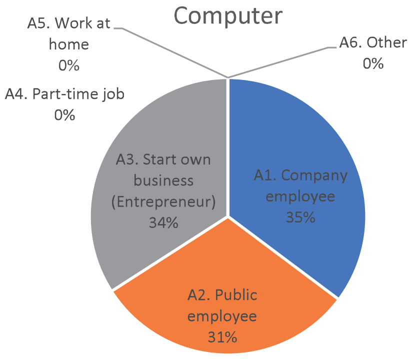
Other: N/A



Other: N/A

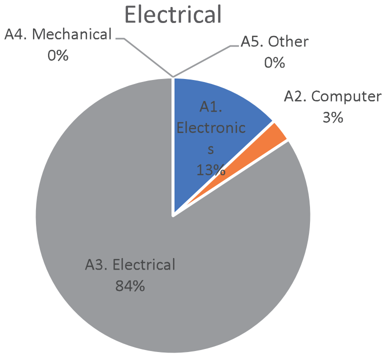


Other: Government job, Training, , etc.

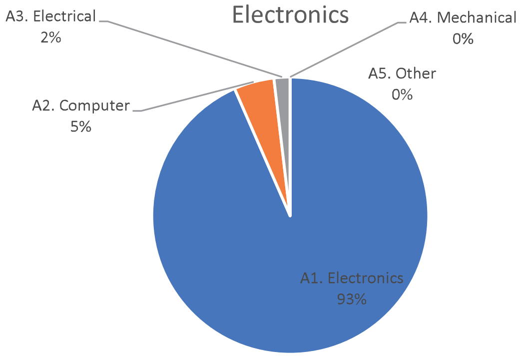


Other: N/A

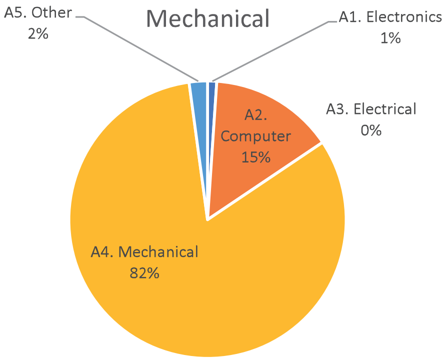
Q3. If you want to find a job, in which field do you want to work? (Select only one)



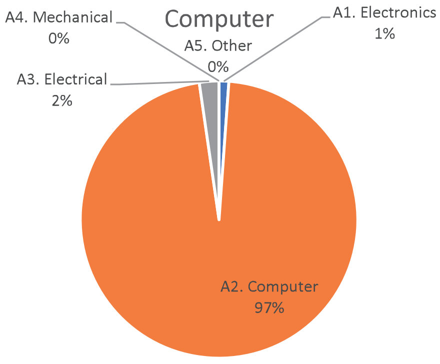
Other: N/A



Other: N/A

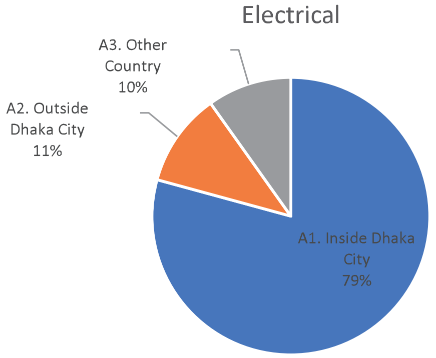


Other: Business, etc.

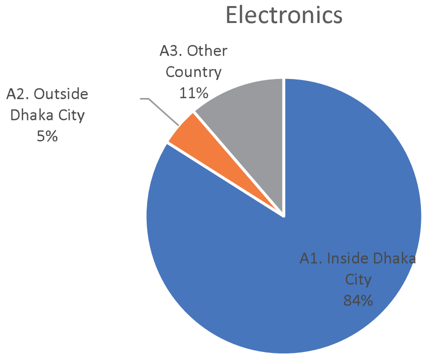


Other: N/A

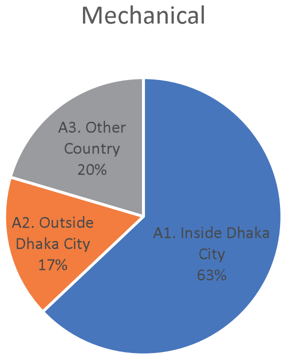
Q4. If you want to find a job, where do you want to work? (Select only one)



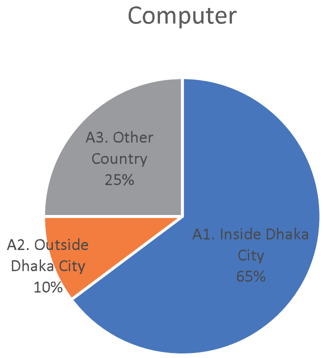
Other Country: Japan, USA, Anywhere



Other Country: Japan, Germany



Other Country: Japan, Korea, Germany, Canada, USA, UK



Other Country: Japan, Germany, Canada, Australia, Korea

Q5. If you have any specific company/organization where you want to work, please describe the name of company/organization

Electrical

PGCB (64), DESCO (55), PDB (39), Boshundhara group (10), BREB (8), NESCO (5), Akij Group (5), Energy Pack (5), Power Plant Company (4), etc.

Electronics

Samsung (32), DESCO (19), Walton (14), PDB (14), Tobacco Company (9), PGCB (8), NESCO (4), BTV (3), City Group (3), Grameenphone (2), etc.

Mechanical

BITAC (28), PDB (8), DESCO (7), Uniliver Bangladesh (7), TOYOTA Company (6), Bangladesh Ordance Factory (6), PGCB (7), Nestle Bangladesh (5), Square Pharmaceutical Company (5), Nasir Group (4), Meghna Group (4), Bangladesh Machine Tools Factory (4), Honda Motor (4), EGCB (3), Bangladesh Railway (3), ACI Company (2), Boeing (2), Walton (2), Runner Group (2), Dhaka EPZ (2), etc.

Computer

Google (12), Adn Telecommunication (6), ICT Ministry (6), Bangladesh Bank (3), UY Lab (2), Naztech Corporate (2), Nitol Niloy Group (2), etc.

Q6. If you know any Japanese companies in Bangladesh, please describe the name of the companies

Electrical

JICA (43), Japan Tobacco (22), OSS Japan (20), JBCCI (11), Toyota (5), Honda (1), Sony (1), etc.

Electronics

Toyota (28), Japan Tobacco (28), JICA (9), Honda (4), Mitsubishi (2), Toshiba (2), Sony (1), etc.

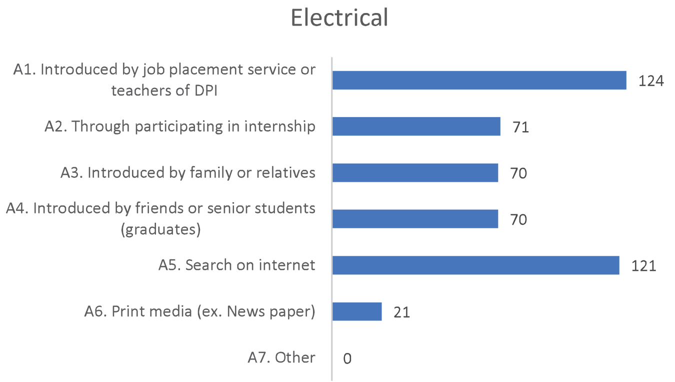
Mechanical

JICA (25), Honda (23), Toyota (13), Japan Tobacco (10), Suzuki (6), Mitsubishi (4), Toshiba (3), MCCI Japanese Company (2), Nissan (1), etc.

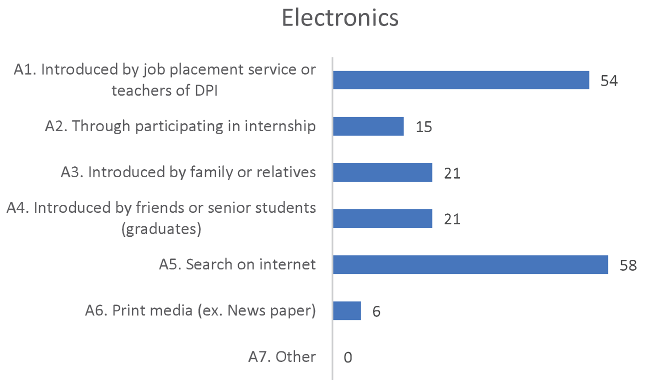
Computer

Japan Tobacco (10), Suzuki (10), Honda (7), Sony (4), OSS Japan (4), Mitsubishi (2), JICA (2), Yamaha (2), JETRO (1), etc.

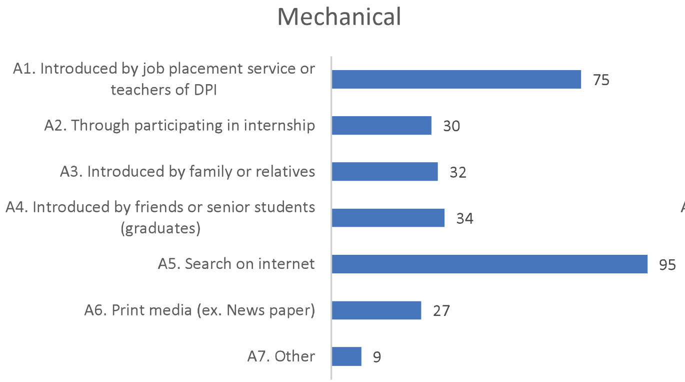
Q7. How do you find information on job opportunity? (Select all that apply)



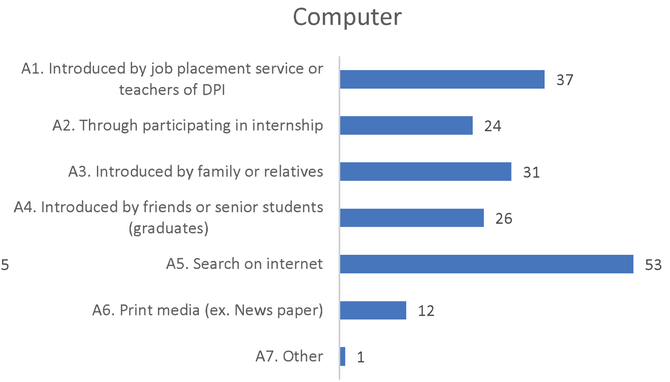
Other: N/A



Other: N/A

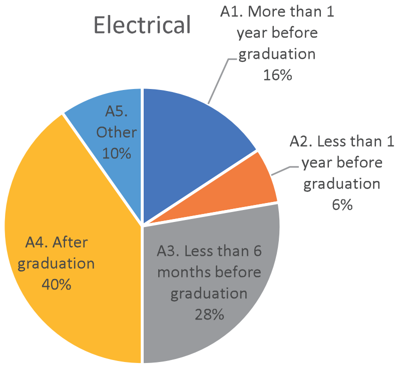


Other: Facebook group, social communication

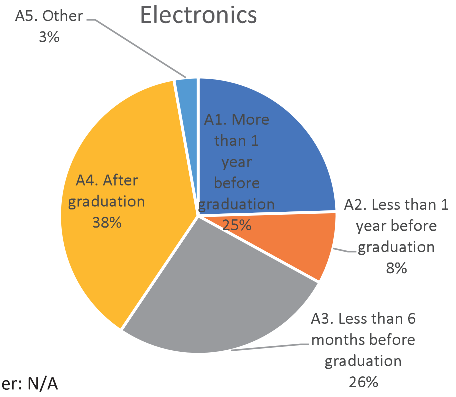


Other: Facebook

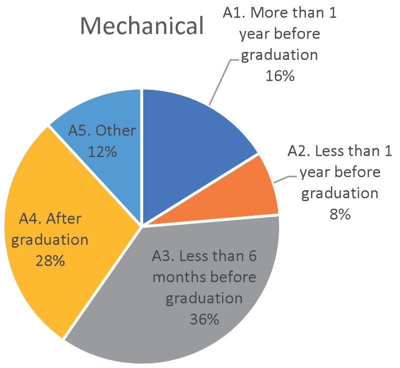
Q8. When do you think is the most appropriate period to start job hunting? (Select only one)



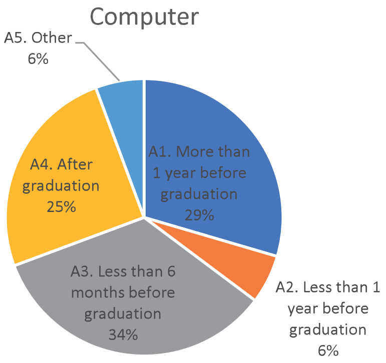
Other: N/A



Other: N/A

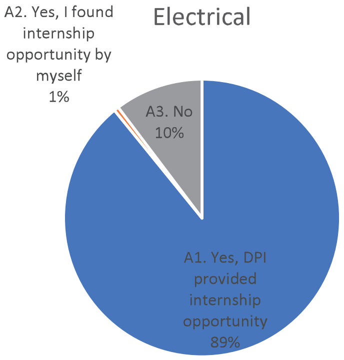


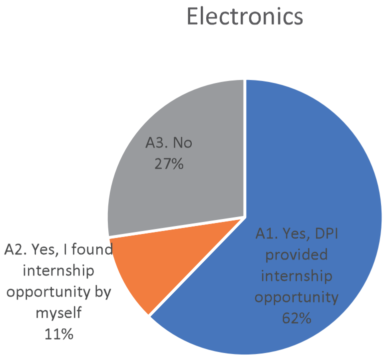
Other: Training period, After completing diploma,

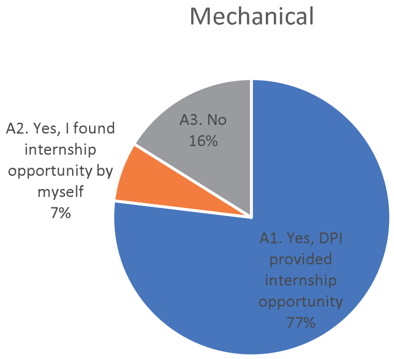


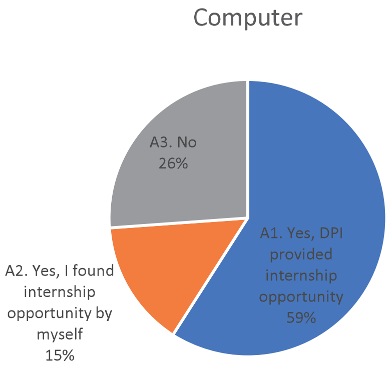
Other: N/A

Q9. Did you participate in internship? (Select all that apply)

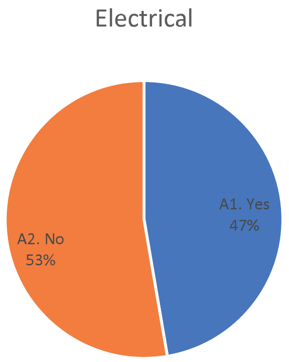


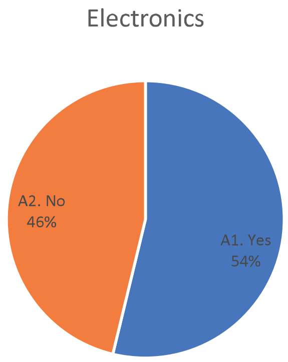


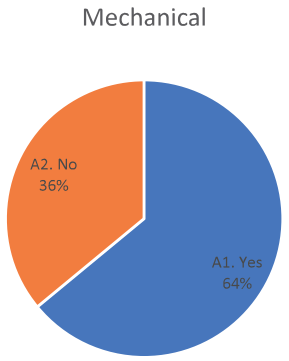


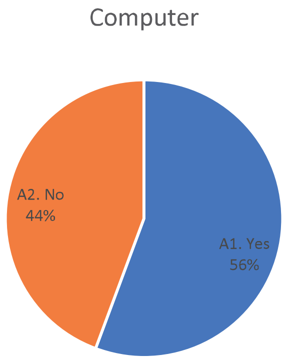


Q10. Did you participate in job placement events provided by DPI such as job fair, seminar, training, site tour, etc.?

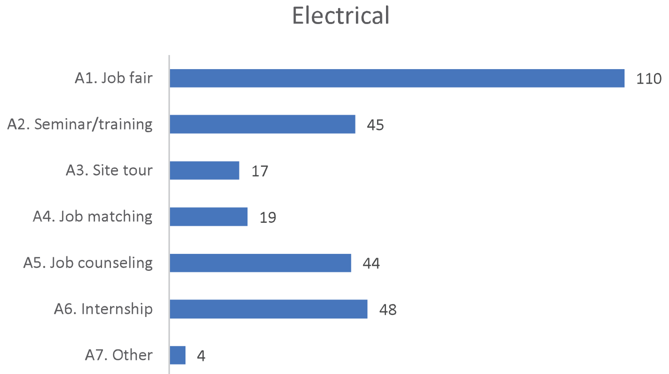

Electrical


Electronics

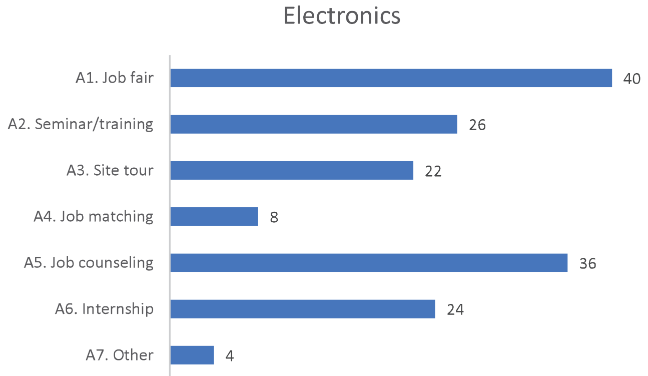

Mechanical


Computer

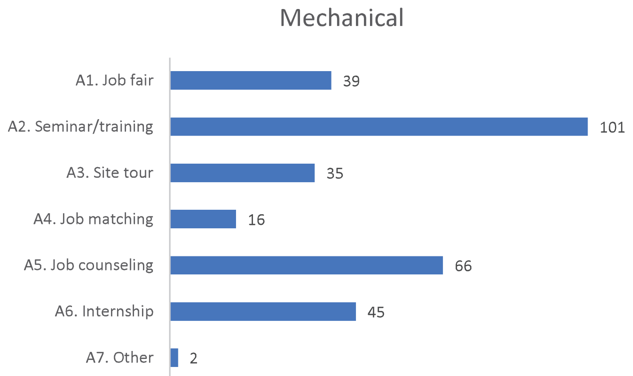
Q11. Which job placement services provided by DPI have you been satisfied with? (Select all that apply)


Electrical

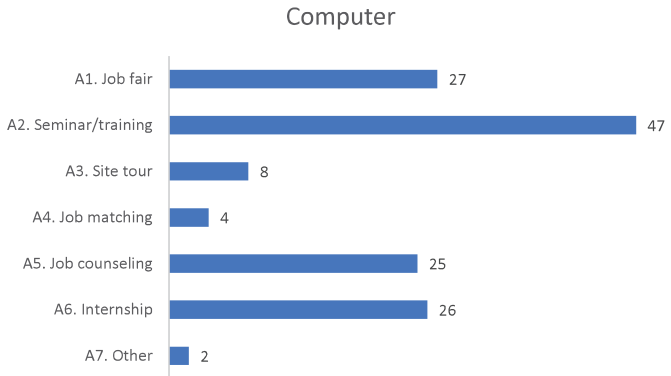
Other: Not satisfied


Electronics

Other: N/A

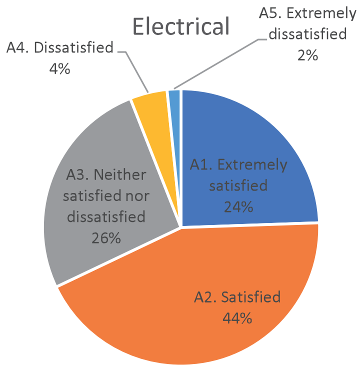

Mechanical

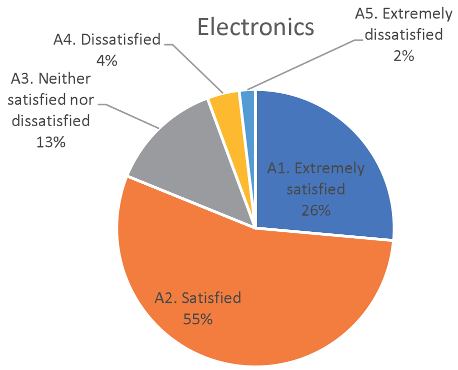
Other: N/A

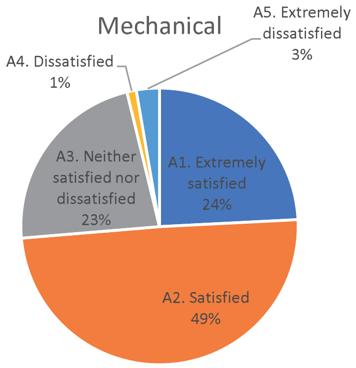

Computer

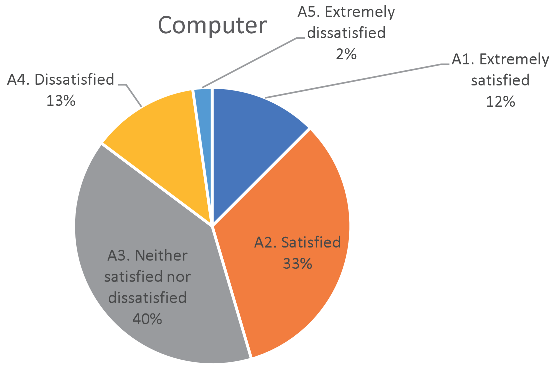
Other: N/A

Q12. Overall, have you been satisfied with the job placement services provided by DPI? (Select only one)

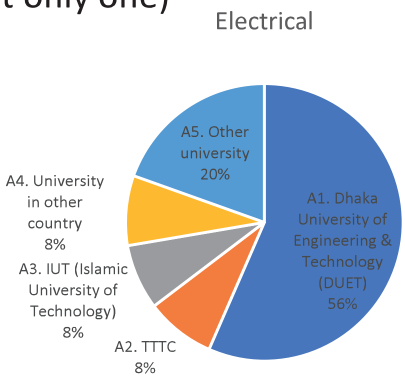




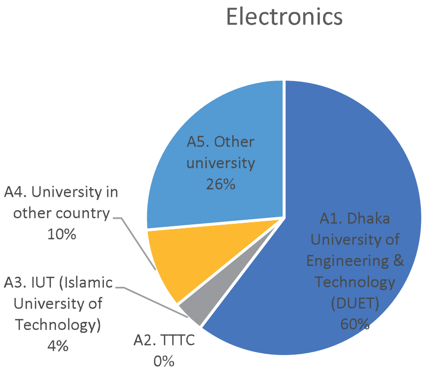




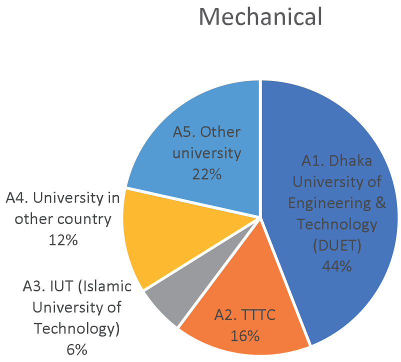
Q13. If you want to proceed to higher education, in which school do you want to study? (Select only one)



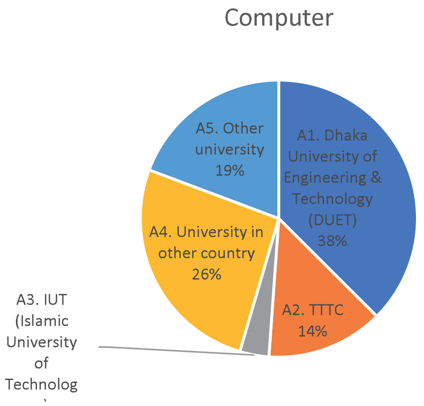
Other University: Daffodil University, AMEI, AIUB, IUBAT, Southeast University, Green University, etc.



Other University: Asia Pacific, Daffodil International University, Green University, Shajalal University, etc.



Other University: Sonargaon University, City University, AMIE, IUBAT, etc.



Other University: , Daffodil International IUB, Southeast University

Q14. If you have any suggestion for the future improvement of job placement service, please describe

Electrical

Need Support to get job (25), Need support to fresher for getting job (23), Increase job fair (14), Increase seminar (12), Upgrade communication with industry (4), Need to arrange training (4), etc.

Electronics

Need publicity to job placement work (16), Increase job fair (9), Need support to get job (7), Need to develop myself (3), Need to build up communication with student (3), etc.

Mechanical

Increase job fair (27), Support to get training (16), Need to increase communication with industry (13), Increase seminar (11), Job Placement cell officer help to students (7), etc.

Computer

Increase job fair (7), Need to enhance practical work (5), Need increase communication with industry (4), etc.

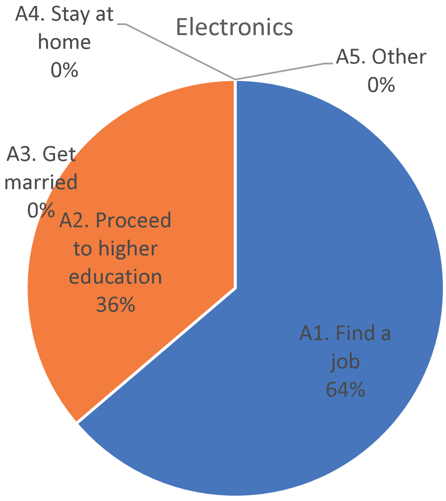
Result of Pre-graduation Survey of 8th semester's students on Job Placement in 2019

Dhaka Mohila Polytechnic Institute (DMPI)

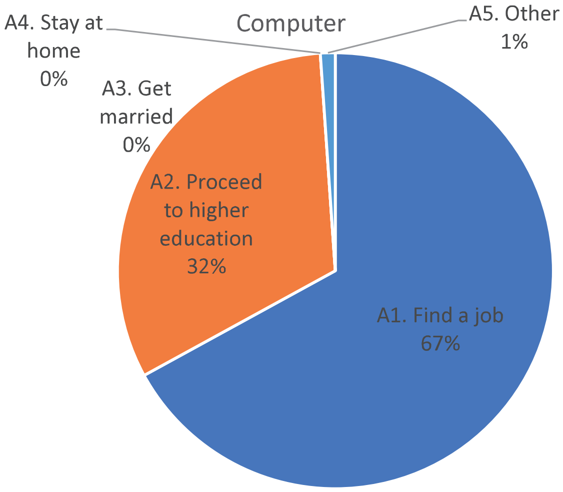
Number of Respondents

Technology	Total
Electronics	69
Computer	91
Total	160

Q1. What is your preferred career path after graduation? (Select only one)

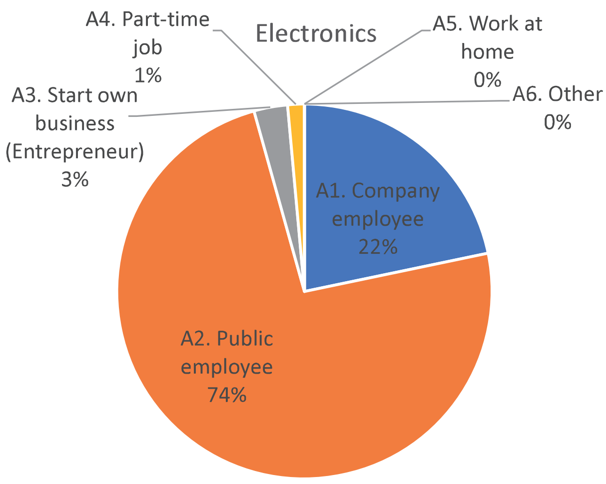


Other: N/A

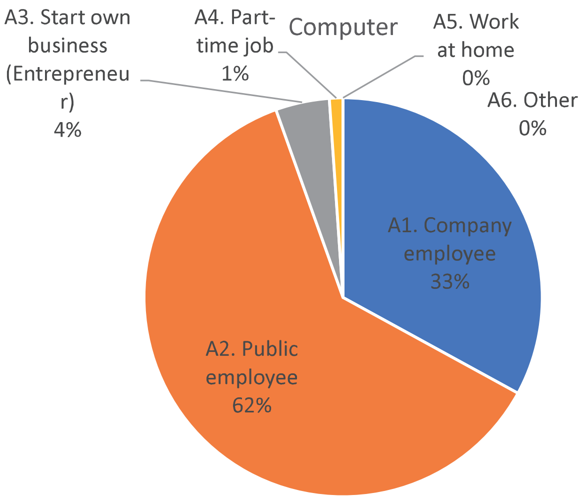


Other: Entrepreneur

Q2. If you want to find a job, what types of job do you want? (Select only one)

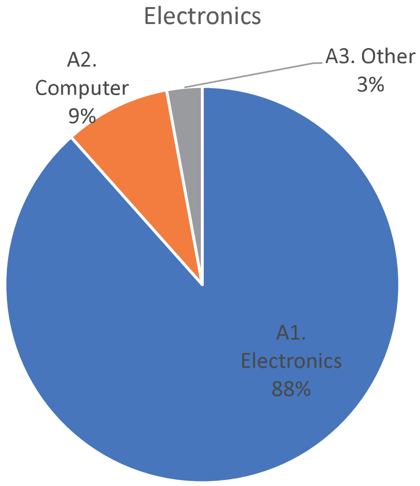


Other: N/A

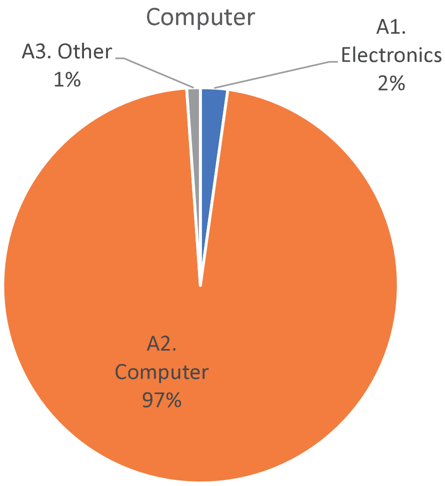


Other: N/A

Q3. If you want to find a job, in which field do you want to work? (Select only one)

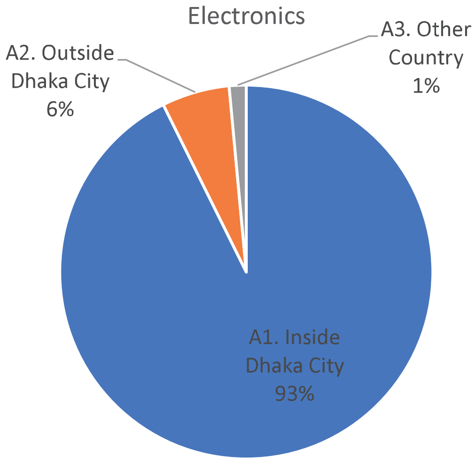


Other: N/A

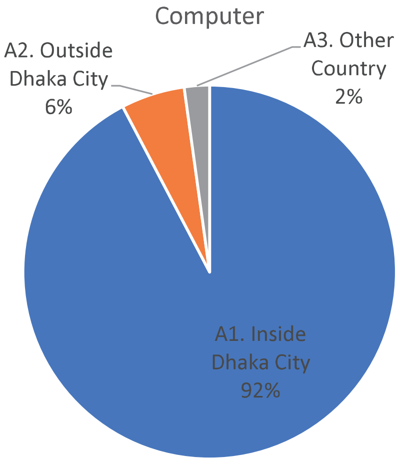


Other: N/A

Q4. If you want to find a job, where do you want to work? (Select only one)



Other Country: Dubai, Malaysia



Other Country: Japan

Q5. If you have any specific company/organization where you want to work, please describe the name of company/organization

Electronics

DESCO (27), PDB (21), Walton (20), NESCO (13), Samsung (12), PGCB (11), Rangs (11), DPDC (10), Bangladesh Railway (10), Titas (10), BREB (10), Singer Company (10), Toyota (9),Toshiba (8), Acme (6), Myone (5), Symphony (3), etc.

Computer

PDB (15), Bangladesh Computer Council (12), DESCO (10), ICT tower (7), Bangladesh Bureau of Statistics (6), Petro Bangla (4), Datasoft Systems (3), Telecom company (2), Bangladesh Bank (2), etc.

Q6. If you know any Japanese companies in Bangladesh, please describe the name of the companies

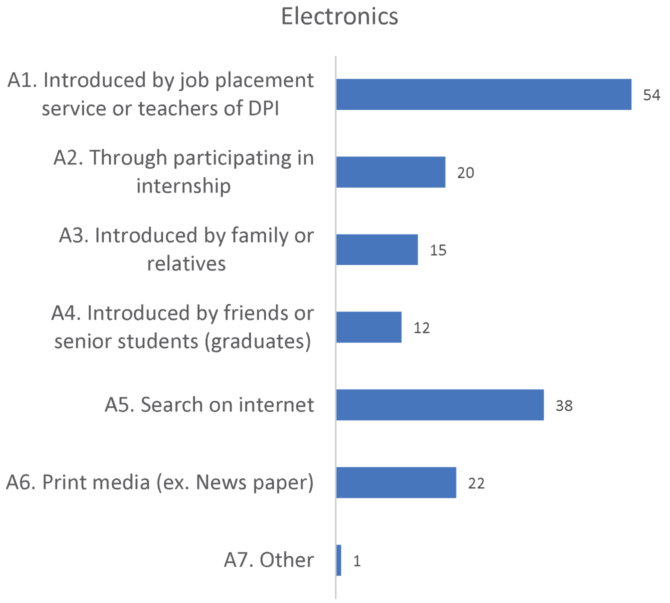
<u>Electronics</u>

Toyota (68), Toshiba (64), Sony (28), Mitsubishi (25), OSS Japan (2), etc.

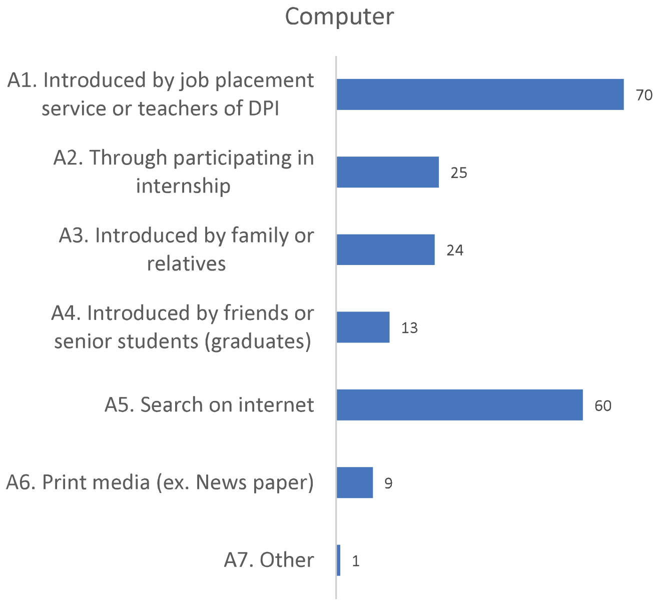
<u>Computer</u>

Toshiba (34), Toyota (27), Mitsubishi (12), Datasoft system (5), JICA (3), Sharp (3), OSS Japan (3), Japan Tobacco (2), JBCCI (2), etc.

Q7. How do you find information on job opportunity? (Select all that apply)

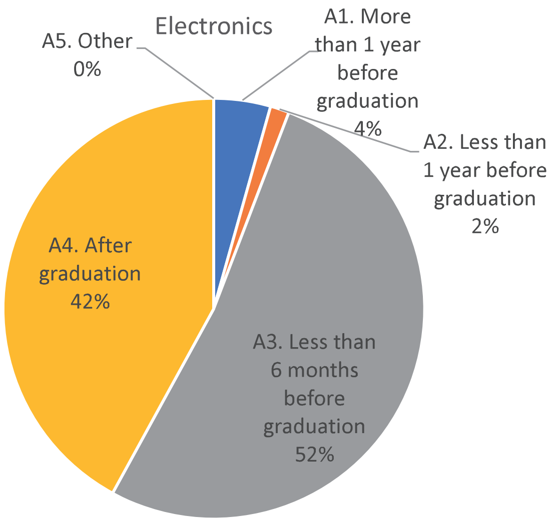


Other: N/A

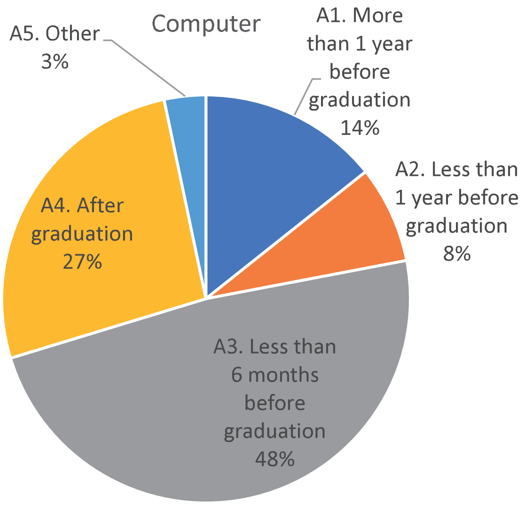


Other: N/A

Q8. When do you think is the most appropriate period to start job hunting? (Select only one)

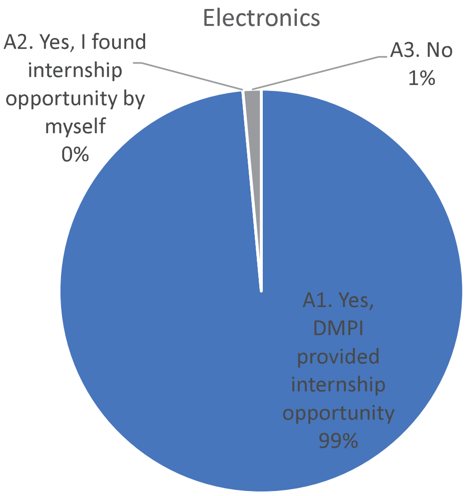


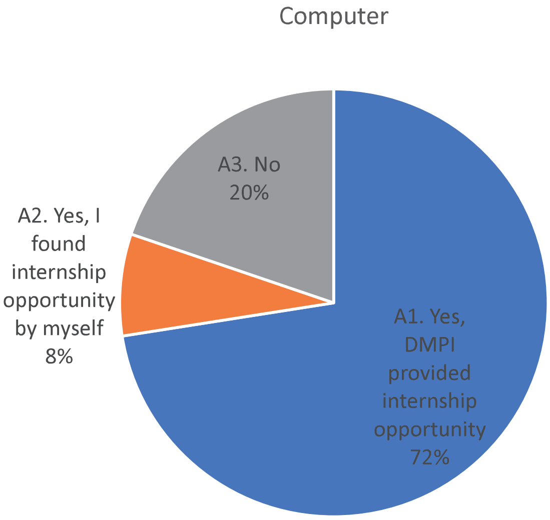
Other: N/A



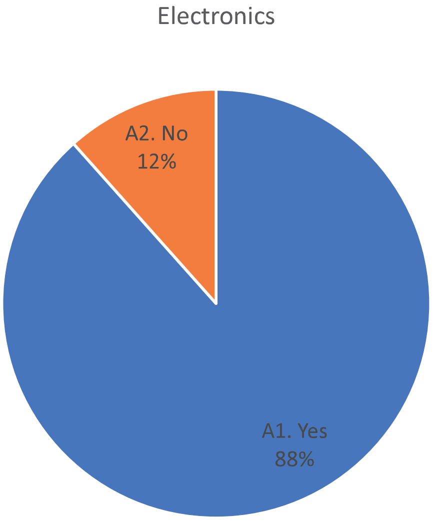
Other: After completing higher education

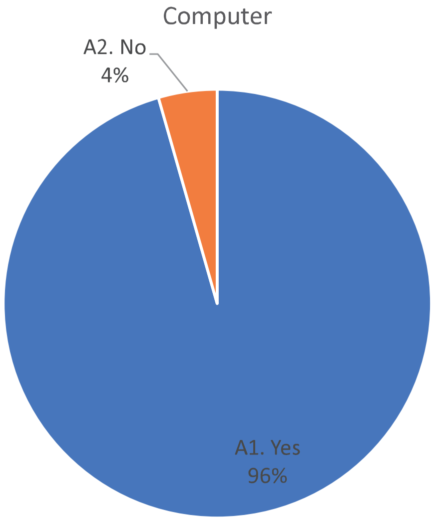
Q9. Did you participate in internship? (Select all that apply)



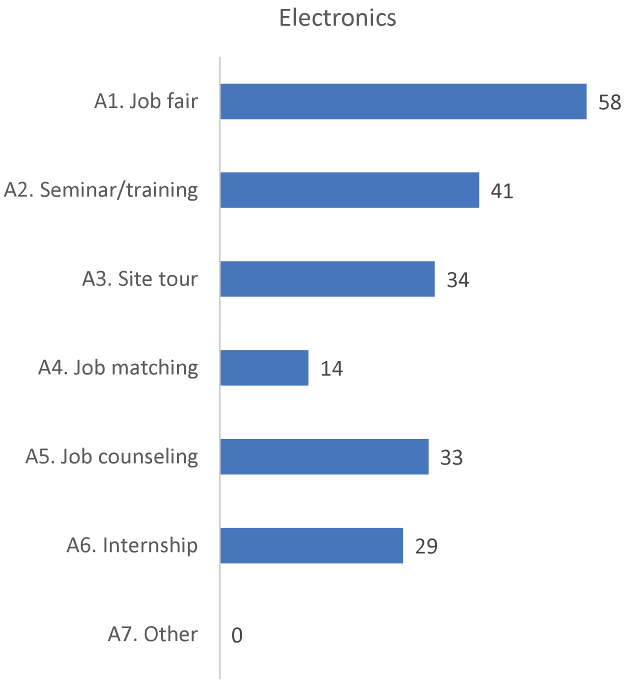


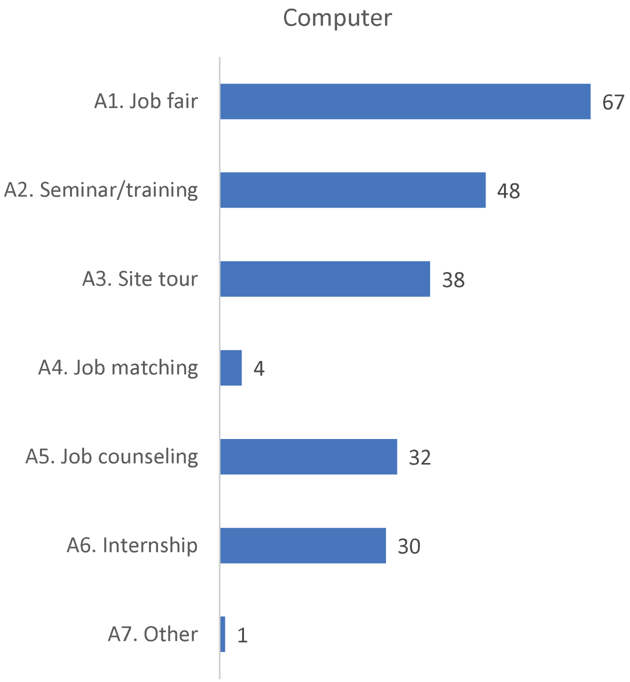
Q10. Did you participate in job placement events provided by DMPI such as job fair, seminar, training, site tour, etc.?





Q11. Which job placement services provided by DMPI have you been satisfied with? (Select all that apply)

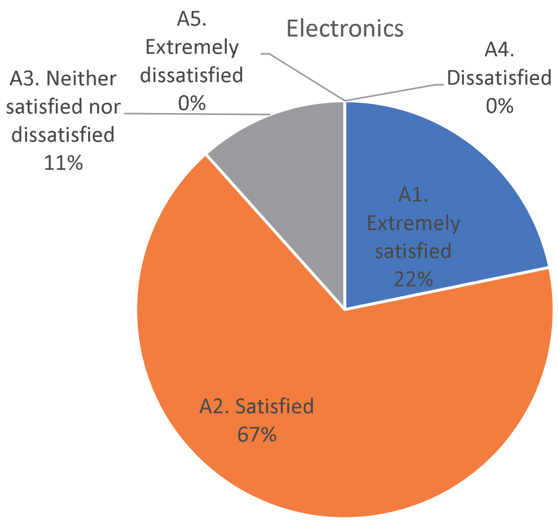


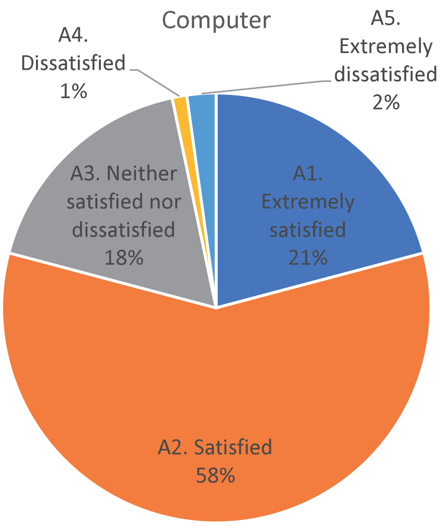


Other: N/A

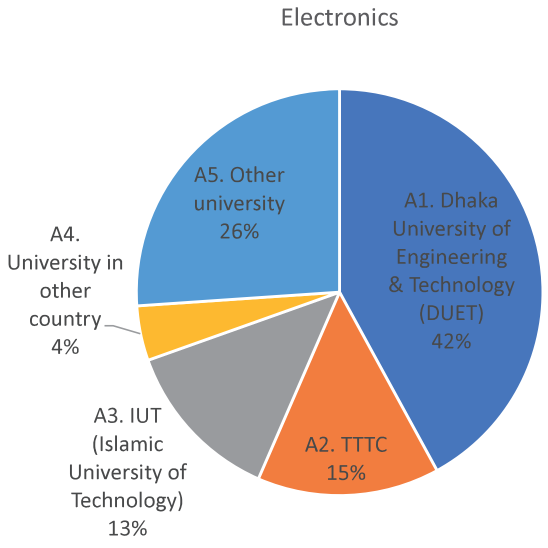
Other: N/A

Q12. Overall, have you been satisfied with the job placement services provided by DMPI? (Select only one)

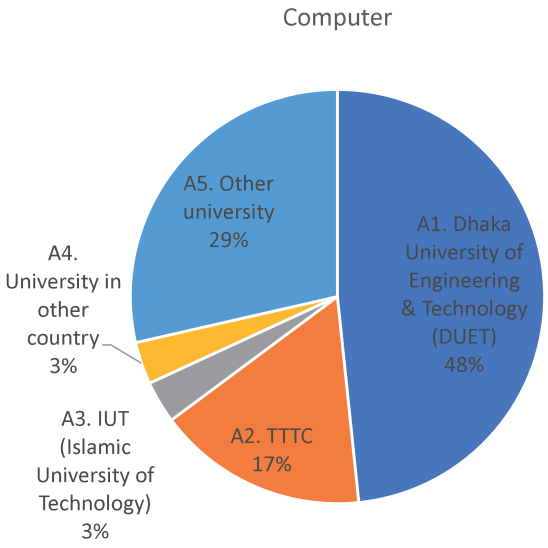




Q13. If you want to proceed to higher education, in which school do you want to study? (Select only one)



Other University: Southeast University, Daffodil University, Green University, Manarat International University, etc.



Other University: Daffodil International University, Sahjalal University of Science & Technology, Southeast University, Green University, etc.

Q14. If you have any suggestion for the future improvement of job placement service, please describe

Electronics

We are satisfied (18), Need update (18), Job placement cell service is very important for us (8), Increase seminar (1), Increase job fair (1), etc.

Computer

Need database software for job searching (12), Need support to get a job (11), Need to improve relationship with more company (9), Need support to get a scholarship (2), etc.

Appendix 1-2: Action plan for improving technical education

ACTION PLAN

For improving technical education

Dhaka Polytechnic Institute, Dhaka Mohila Polytechnic Institute

Activities	Sub-activities	Input (Staff, equipment, budget)	Person in charge	Deadline	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1. Make Competancy Mapping	1.1 Workshop with industry persons	1. HoD, Faculty member (DPI, DMPI & TTTC) & Industry Persons,Represetative (DTE & BTEB) 2. Budget from Project	Principal/ Vice-Principal/HoD			🟨						🟨						🟨						🟨						🟨					
	1.2 Make a Experiment List					🟦						🟦						🟦						🟦						🟦					
	1.3 Prepare Job/Experiment sheet						🟦						🟦						🟦						🟦						🟦				
2. Training for Teacher's	2.1 Conduct In-house Training for faculty members according to 1.3	HoD, Faculty members	HoD				🟨			🟨			🟨			🟨			🟨			🟨			🟨			🟨			🟨			🟨	
	2.2 Training program conducted by TTTC	.	Principal/HoD (TTTC)															🟦												🟦					🟦
	2.3 Training by KOSEN	1. HoD, Faculty members (Pilot Polytechnic Institutes, TTTC) 2. Budget from Project	Principal (TTTC) / KOSEN Professors						🟦						🟦		🟦				🟦						🟦		🟦				🟦		
3. Prepare Hand-on Material	3.1 Prepare Hand-on Materials for Teachers Training	1. HoD, Faculty members (Pilot Polytechnic Institutes, TTTC) & KOSEN Prof. 2. Budget from Project	Principal/HoD (TTTC)							🟨						🟨		🟨				🟨						🟨		🟨				🟨	
	3.2 Feedback from Training & Review the Materials	1. HoD, Faculty members (Pilot Polytechnic Institutes, TTTC) 2. Budget from Project	Principal/HoD (TTTC)								🟩						🟩		🟩				🟩						🟩		🟩				🟩
	3.3 Prepare Hand-on Materials for Students	1. HoD, Faculty members (Pilot Polytechnic Institutes, TTTC) 2. Budget from Project	Principal/HoD (TTTC)									🟨						🟨		🟨				🟨						🟨		🟨			🟨
	3.4 Collect feedback from students & Modify Hand-on Materials	1. HoD, Faculty members (Pilot Polytechnic Institutes, TTTC) 2. Budget from Project	Subject Teacher & HoD (Polytechnic)										🟩						🟩		🟩				🟩						🟩		🟩		
4. Practice with Project Based Learning (PBL)	4.1 Design PBL / Project	Students, Subject Teacher & HoD	Subject Teacher, HoD & VP (Polytechnic)			🟦						🟦						🟦						🟦						🟦					
	4.2 Assigning of the Project	Students, Subject Teacher & HoD	Subject Teacher & HoD (Polytechnic)				🟦						🟦						🟦						🟦						🟦				
	4.3 Prepare Project	Supporting Staff, Students, Subject Teacher & HoD, Raw Materials	Subject Teacher & HoD (Polytechnic)					🟦	🟦	🟦	🟦			🟦	🟦	🟦	🟦			🟦	🟦	🟦	🟦			🟦	🟦	🟦	🟦			🟦	🟦	🟦	🟦
	4.4 Poster Presentation of Project Work	Students, Subject Teacher, HoD & KOSEN Professors, Principal, Vice Principal, TTTC & DTE	Subject Teacher & HoD (Polytechnic), VP & Principal									🟦						🟦						🟦						🟦					🟦
	4.5 Evaluate Project	1. Subject Teacher, HoD, Industry persons & KOSEN Professors	Subject Teacher & HoD (Polytechnic), VP & Principal									🟦						🟦						🟦						🟦					🟦
5. Develop Monitoring & Assessment System	5.1 Do survey (using the check lists)	Using the Teacher skill check lists & Student satisfaction survey, Students, Subject Teacher & HoD, KOSEN Professors	HoD, VP & Principal						🟦												🟦												🟦		
	5.2 Analysis the data	Teachers, HoD & KOSEN Professors	HoD, VP & Principal						🟦												🟦												🟦		
	5.3 Make report	Teachers, HoD & KOSEN Professors	HoD, VP & Principal							🟦												🟦												🟦	
	5.4 Discuss with the Teachers (Collect feedback)	Teachers, HoD & KOSEN Professors	HoD, VP & Principal										🟦						🟦						🟦						🟦				
	5.5 Implement the feedback	Teachers, HoD & KOSEN Professors	HoD, VP & Principal											🟦						🟦						🟦						🟦			
6. Prepare a Guideline	**6.1 Record Keeping:**					🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦				
	6.1.1 Competancy Mapping	Data	Principal/ Vice-Principal/HoD																																
	6.1.2 Training for Teachers	Data	HoDs, VP, Principal (DMPI, DPI,TTTC) & KOSEN Professors																																
	6.1.3 Hand-on Materials	Data	HoDs, VP, Principal (DMPI, DPI,TTTC) & KOSEN Professors																																
	6.1.4 Project Base Learning	Projects & Data	Teachers, HoDs, VP, Principal (DMPI, DPI,TTTC) & KOSEN Professors																																
	6.1.5 Monitoring & Assesment	Data	Teachers, HoDs, VP, Principal (DMPI, DPI,TTTC) & KOSEN Professors																																
	6.2 Develop the guideline.	1. Teachers, HoDs, VP, Principal (DMPI, DPI,TTTC) , KOSEN Professors ,DTE & BTEB, 2. Budget from Project	Principal (TTTC)																													🟦	🟦	🟦	
	6.3 Recommendations *																																		🟦
7. Dessimanition of ipmroved Technical Education System	Dessemination through the guideline	DTE, BTEB, TTTC and All Polytechnic Institute	DTE, TTTC																																🟦

🟦 Regular activity, Office work, preparation
🟨 Event, Lecture/Seminar, Survey
🟩 Briefing/Feedback session
🟥 Students' Internship

*** Recommendations:**

- Arrange for some selective students to be required as interns at Japanese NITs for one semester i.e, 4 ~ 6 months and Need to figure out the source of finance (JASSO, MEXT, Self, GoB, etc.)
- Enrolling as an Avanced course students at NITs, after polytechnic graduation and Need to figure out the source of finance (JASSO, MEXT, Self, GoB, etc.)
- Arrange for Teachers to be required as interns at Japanese NITs for one semester (4 ~ 6 months) and Need to figure out the source of finance (JASSO, MEXT, Self, GoB, etc.)
- Establishment of research/Project Labs
- Develop Project/research based syllabus

Appendix 1-3: Action plan for job placement support

ACTION PLAN

For Job Placement

Dhaka Polytechnic Institute

December, 2019

					2019	2020												2021												2022				
Activities	**Sub-activities**	**Input (Staff, equipment, budget)**	**Person in charge**	**Deadline**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
1. Collect information on private companies																																		
1-1. Collect information on private companies' job offer and employment	▼ Collect information on private companies related to four target technologies and make lists of the companies	<DPI> Job Placement Officer Staff in charge of Job Placement Cell <JICA Project> Japanese Expert x1 Office Manager x1 PC x1 Paper Printing Cost	Job Placement Officer Staff in charge of Job Placement Cell	End of the project	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
	▼ Collect information on job offer and employment of the listed companies						🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
	▼ Analyze the trend of human resource needs of the companies through the information on job offer								🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
1-2. Collect information on performance of the graduates	▼ Conduct questionnare survey of the companies who hired graduates			Once a year (every October)											🟨												🟨							
	▼ Sort out and analyze the survey result and give feedback to TOT and seminars			Once a year (every November)												🟦												🟦						
2. Promote communication with industry																																		
2-1. Organize lectures and/or recruitment seminars with industry	▼ Select topics and targets of lectures/seminars based on the human resource needs of the companies	<DPI> Job Placement Officer Staff in charge of Job Placement Cell Lecture/seminar room Projector <JICA Project> Local Consultant x1 Office Manager x1 Honorarium for a lecturer	Job Placement Officer Staff in charge of Job Placement Cell	2lectures/seminars per year (every June and December)					🟦						🟦						🟦						🟦						🟦	
	▼ Select lecturers of lectures/seminars								🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦
	▼ Organize schedule and venue of lectures/seminars and prepare questionnaire form								🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦
	▼ Conduct lectures/seminars										🟨						🟨						🟨						🟨					
	▼ Conduct feedback session of the lectures/seminars, sort out questionnare responses, and keep the records										🟩						🟩						🟩						🟩					
2-2. Coordinate internship program with industry	▼ Arrange and coordinate students' internship with companies	<DPI> Job Placement Officer Teachers in charge of "Industrial Attachment" subject <JICA Project> Japanese Expert x1 Office Manager x1	Job Placement Officer Teachers in charge of "Industrial Attachment" subject	12weeks internship in every year for 8th semester students	🟦	🟦											🟦	🟦											🟦	🟦				
	▼ Conduct internship preparation briefing					🟩												🟩												🟩				
	▼ Participate internship by students						🟥	🟥	🟥										🟥	🟥	🟥										🟥	🟥	🟥	
	▼ Conduct feedback session of intetnship participation and keep the records									🟩												🟩												🟩
2-3. Organize job fair with industry	▼ Develop a plan of the job fair including objectives, schedule, venue, targets, etc.	<DPI> Job Placement Officer Staff in charge of Job Placement Cell Venue Furniture <JICA Project> Japanese Expert x1 Local Consultant x2 Office Manager x1 Stationery Printing and PR cost	Job Placement Officer Staff in charge of Job Placement Cell	Hold a job fair once a year (every November)									🟦												🟦									
	▼ Select participating companies and send offers for their participation													🟦	🟦											🟦	🟦							
	▼ Make public announcement and conduct PR activities													🟦	🟦											🟦	🟦							
	▼ Prepare the job fair (company list, venue map, furniture, stationery, banner, posters, handouts, questionnaire, etc.)														🟦												🟦							
	▼ Hold the job fair															🟨												🟨						
	▼ Conduct feedback session of the job fair, sort out questionnaire responses, and keep the records															🟩												🟩						
3. Enhance employment support																																		
3-1. Enhance career counseling for employment	▼ Design a system and make a plan of career counseling	<DPI> Job Placement Officer Teachers in charge of career counseling <JICA Project> Japanese Expert x1 Office Manager x1	Job Placement Officer Teachers in charge of career counseling	January 2020	🟦	🟦																												
	▼ Develop a manual for teachers in charge of the career couseling			March 2020			🟦	🟦																										
	▼ Conduct regular career counseling for students and keep couseling records			Once a year (every April)					🟨												🟨												🟨	
3-2. Enhance job matching support for employment	▼ Design a system and make a plan to disseminate the information on job offer and employment of companies	<DPI> Job Placement Officer Staff in charge of Job Placement Cell Teachers in charge of job matching <JICA Project> Japanese Expert x1 Office Manager x1	Job Placement Officer Staff in charge of Job Placement Cell Teachers in charge of job matching	May 2020					🟦	🟦																								
	▼ Develop a system to receive job offer from companies and introduce students who match the condition			July 2020							🟦	🟦																						
	▼ Conduct regular job matching for students and keep matching records			End of the project									🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
4. Create database on job placement																																		
4-1. Create a database of current students	▼ Conduct questionnaire survey of 8th semester students on their future career	<DPI> HOD Computer Job Placement Officer Staff in charge of Job Placement Cell <JICA Project> Japanese Expert x1 Office Manager x1 PC x1 Paper Printing cost	HOD Computer Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every July)								🟨												🟨										
	▼ Sort out and analyze the survey result			Once a year (every August)									🟦												🟦									
	▼ Update the database			Once a year (every September)										🟦												🟦								
4-2. Create a database of graduates	▼ Conduct questionnaire survey of ex-students who graduated one year ago and wanted to get a job		HOD Computer Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every July)								🟨												🟨										
	▼ Sort out and analyze the survey result			Once a year (every August)									🟦												🟦									
	▼ Update the database			Once a year (every September)										🟦												🟦								
4-3. Create an alumni network	▼ Generate/update a mailing list and/or SNS page of graduates based on the database		HOD Computer Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every October)											🟦												🟦							
	▼ Design a system to share the latest information on job offer, employment, etc. through the alumni network			October 2020			🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																			
	▼ Develop and manage the system for the alumni network's activities			End of the project												🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦

🟦 Regular activity, Office work, preparation

🟨 Event, Lecture/Seminar, Survey

🟩 Briefing/Feedback session

🟥 Students' Internship

ACTION PLAN

For Job Placement **Dhaka Mohila Polytechnic Institute** **December, 2019**

					2019	2020												2021												2022				
Activities	**Sub-activities**	**Input (Staff, equipment, budget)**	**Person in charge**	**Deadline**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
1. Collect information on private companies																																		
1-1. Collect information on private companies' job offer and employment	▼ Collect information on private companies related to two target technologies and make lists of the companies	<DMPI> Job Placement Officer Staff in charge of Job Placement Cell <JICA Project> Japanese Expert x1 Assistant Office Manager x1 PC x1 Paper Printing Cost	Job Placement Officer Staff in charge of Job Placement Cell	End of the project	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
	▼ Collect information on job offer and employment of the listed companies						🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
	▼ Analyze the trend of human resource needs of the companies through the information on job offer								🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
1-2. Collect information on performance of the graduates	▼ Conduct questionnare survey of the companies who hired graduates			Once a year (every October)											🟨												🟨							
	▼ Sort out and analyze the survey result and give feedback to TOT and seminars			Once a year (every November)												🟦												🟦						
2. Promote communication with industry																																		
2-1. Organize lectures and/or recruitment seminars with industry	▼ Select topics and targets of lectures/seminars based on the human resource needs of the companies	<DMPI> Job Placement Officer Staff in charge of Job Placement Cell Lecture/seminar room Projector <JICA Project> Local Consultant x1 Assistant Office Manager x1 Honorarium for a lecturer	Job Placement Officer Staff in charge of Job Placement Cell	2lectures/seminars per year (every May and November)				🟦						🟦						🟦						🟦						🟦		
	▼ Select lecturers of lectures/seminars							🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦	
	▼ Organize schedule and venue of lectures/seminars and prepare questionnaire form							🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦					🟦	🟦	
	▼ Conduct lectures/seminars									🟨						🟨						🟨						🟨						🟨
	▼ Conduct feedback session of the lectures/seminars, sort out questionnare responses, and keep the records									🟩						🟩						🟩						🟩						🟩
2-2. Coordinate internship program with industry	▼ Coordinate and Arrange students' leadership ability and internship with relevent companies	<DMPI> Job Placement Officer Teachers in charge of "Industrial Attachment" subject HOD computer <JICA Project> Japanese Expert x1 Assistant Office Manager x1	Job Placement Officer HOD computer Teachers in charge of "Industrial Attachment" subject	12weeks internship in every year for 8th semester students	🟦	🟦											🟦	🟦											🟦	🟦				
	▼ Conduct internship and leadership information briefing					🟩												🟩												🟩				
	▼ Participate internship by students						🟥	🟥	🟥										🟥	🟥	🟥										🟥	🟥	🟥	
	▼ Conduct feedback session of intetnship participation and keep the records									🟩												🟩												🟩
2-3. Organize job fair with industry	▼ Develop a plan of the job fair including objectives, schedule, venue, targets, etc.	<DMPI> Job Placement Officer Staff in charge of Job Placement Cell Venue Furniture <JICA Project> Japanese Expert x1 Local Consultant x2 Assistant Office Manager x1 Stationery Printing and PR cost	Job Placement Officer Staff in charge of Job Placement Cell. HOD cmt	Hold a job fair once a year (every November)									🟦												🟦									
	▼ Select participating companies and send offers for their participation													🟦	🟦											🟦	🟦							
	▼ Make public announcement and conduct PR activities													🟦	🟦											🟦	🟦							
	▼ Prepare the job fair (company list, venue map, furniture, stationery, banner, posters, handouts, questionnaire, etc.)														🟦												🟦							
	▼ Hold the job fair															🟨												🟨						
	▼ Conduct feedback session of the job fair, sort out questionnaire responses, and keep the records															🟩												🟩						
3. Enhance employment support																																		
3-1. Enhance career counseling for employment	▼ Design a system and make a plan of career counseling	<DMPI> Job Placement Officer Teachers in charge of career counseling <JICA Project> Japanese Expert x1 Assistant Office Manager x1	Job Placement Officer Teachers in charge of career counseling	January 2020	🟦	🟦																												
	▼ Develop a manual for teachers in charge of the career couseling			March 2020			🟦	🟦																										
	▼ Conduct regular career counseling for students and keep couseling records			Once a year (every April)					🟨												🟨												🟨	
3-2. Enhance job matching support for employment	▼ Design a system and make a plan to disseminate the information on job offer and employment of companies	<DMPI> Job Placement Officer Staff in charge of Job Placement Cell Teachers in charge of job matching <JICA Project> Japanese Expert x1 Assistant Office Manager x1	Job Placement Officer Staff in charge of Job Placement Cell Teachers in charge of job matching	May 2020					🟦	🟦																								
	▼ Develop a system to receive job offer from companies and introduce students who match the condition			July 2020							🟦	🟦																						
	▼ Conduct regular job matching for students and keep matching records			End of the project									🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
4. Create database on job placement																																		
4-1. Create a database of current students	▼ Conduct questionnaire survey of 8th semester students on their future career	<DMPI> HOD Computer Job Placement Officer Staff in charge of Job Placement Cell <JICA Project> Japanese Expert x1 Assistant Office Manager x1 PC x1 Paper Printing cost	HOD Computer Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every July)								🟨												🟨										
	▼ Sort out and analyze the survey result			Once a year (every August)									🟦												🟦									
	▼ Update the database			Once a year (every September)										🟦												🟦								
4-2. Create a database of graduates	▼ Conduct questionnaire survey of ex-students who graduated one year ago and wanted to get a job		HOD Computer Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every July)								🟨												🟨										
	▼ Sort out and analyze the survey result			Once a year (every August)									🟦												🟦									
	▼ Update the database			Once a year (every September)										🟦												🟦								
4-3. Create an alumni network	▼ Generate/update a mailing list and/or SNS page of graduates based on the database		HOD all Job Placement Officer Staff in charge of Job Placement Cell	Once a year (every October)											🟦												🟦							
	▼ Design a system to share the latest information on job offer, employment, etc. through the alumni network			October 2020			🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦																			
	▼ Develop and manage the system for the alumni network's activities			End of the project												🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦

🟦 Regular activity, Office work, preparation

🟨 Event, Lecture/Seminar, Survey

🟩 Briefing/Feedback session

🟥 Students' Internship

Appendix 1-4: Hands-on manuals for practical training and experiment

Samples by KOSEN Professors

Measurement of Voltage, Current and Resistance in DC Circuits (Lv.1)

1. Objective

To learn how to measure voltage, current, and resistance of a DC circuit using a tester.

2. Theory

What is a tester?

It is a very convenient measuring instrument for circuit inspection. It is designed to measure a wide range of voltages, currents, and resistances by switching the range. Testers are indispensable for the maintenance and repair of electrical equipment, but they are not suitable for precise measurements due to their relatively wide tolerance range. However, when precision measurement is not required (maintenance, repair, etc.), testers are very easy to handle and can be very effective.

3. Experiment

3.1 Equipmental Setup & Materials

Tester

AA batteries

Battery box

Fixed resistor R_1:330Ω, R_2:150Ω, R_3:100Ω

Wiring Wire

Electric Clip

3.2 Experimental method

3.2.1 Measurement of resistance

Measure the resistance values of resistors $R_1 \sim R_3$.

[Experimental procedure]

- Read the color code of the resistor to be measured and confirm the nominal resistance value.
- Set the dial of the tester to the appropriate resistance range.
- Short-circuit the tester's probe and make a 0 Ohm adjustment.
- Place the probe on both ends of the resistance to be measured and read the tester's probe.

Table 1. Measurement results of resistance

	Color code	Nominal value of resistance	Measured value of resistance
R_1			
R_2			
R_3			

3.2.2 Measurement of voltage

Measure the voltage E, V_1~V_3 of the circuit shown in Figure 1, respectively.

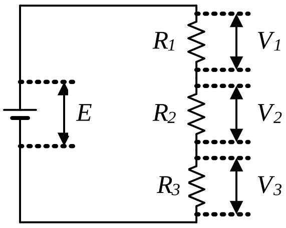


Figure 1: Voltage measurement circuit

[Experimental Procedure]

- Connect three resistors in series with Electric Clips.
- Place the battery in the battery box and connect the resistors with the Electric Clips.
- Set the dial of the tester to the appropriate DC voltage range, anticipating the voltage value to be measured.
- Place a probe on both ends of the battery and measure the battery voltage E.
- Put probes on both ends of each resistor and measure the voltage at both ends of each resistor.

Table 2. Voltage measurement results

E		V_1		V_2		V_3	

3.2.3 Measurement of current

Measure the current I_1~I_3 of the circuit shown in Figure 2 respectively.

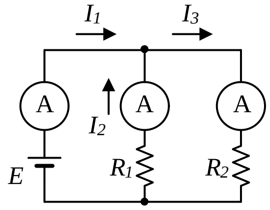


Figure 2: Current measurement circuit

[Experimental procedure]

- Connect the battery and resistors R_1 and R_2 in parallel using a wire and an Electric Clip.
- Connect the red probe of the tester to the wire coming out of the positive side of the battery box, and the black probe to one side of the resistors connected in parallel with an Electric Clip. At this time, do not install the battery yet.
- Use a minnow clip to connect the other side of the parallel resistor to the wire coming out of the negative side of the battery box.
- Anticipate the current to be measured, and set the dial on the tester to the appropriate current range.
- After installing the battery, read the tester's pointer and measure the current I1.
- After removing the battery, insert the tester into a place where I2 can be measured as I3, install the battery in the same way, read the tester's pointer, and measure the current I2 and I3 respectively. The red probe should be connected to the one with the higher voltage.

Table 3. Current measurement results

I_1		I_2		I_3	

4. Discussion

[1] Calculate the error between the measured value and the nominal value obtained from the resistance measurement, and discuss the cause of the error. Note that the tolerance of the resistor itself is shown in the fourth band of the color code.

[2] From the measured voltage, examine the relationship between E and V_1 to V_3 in Figure 1.

[3] From the measured current, what is the relationship between I_1 and I_3 in Figure 2.

Kirchhoff's Law (Lv.2)

1. Objective

Confirmation of Kirchhoff's law by experiment

2. Theory

2.1 Kirchhoff's First Law (Current Law)

At any point in an electric circuit, the sum of the currents flowing into and out of that point is zero. For example, suppose that currents I_1 and I_2 flow into and I_1 flows out of node a of the circuit shown in Figure 1(a).

If the direction of flow in is positive and the direction of flow out is negative, then the following equation holds

$$I_1 + I_2 - I_3 = 0 \qquad (1)$$

2.2 Kirchhoff's Second Law (Voltage law)

When following any closed circuit (closed circuit) in an electric circuit in one direction, the sum of the voltage drop and the sum of the electromotive force in that closed circuit are equal. For example, in a closed circuit like the one shown in Fig. 1(b), if the clockwise direction is positive, then the following equation holds

$$\mathrm{E} = V_1 + V_2 = IR_1 + IR_2 \qquad (2)$$

(a) First Law (Current Law) (b) Second Law (Voltage Law)

Figure 1: Kirchhoff's law

3. Experiment

3.1 Equipment Setup & Materials

Tester : 2 units

D.C. variable bench supply

Fixed resistors 1kΩ×2pcs, 2kΩ

Rheostat(Variable resistors) 2kΩ

Wiring Wire

Electric Clip

3.2 Experimental method

For the circuit shown in Fig. 2, change the resistance R_4 (Variable resistors) and measure the current I_1 to I_4 and the voltage V_1 to V_4 , $R_1 = 1[\mathrm{k}\Omega]$, $R_2 = 2[\mathrm{k}\Omega]$, $R_3 = 1[\mathrm{k}\Omega]$ and $E = 5[\mathrm{V}]$.

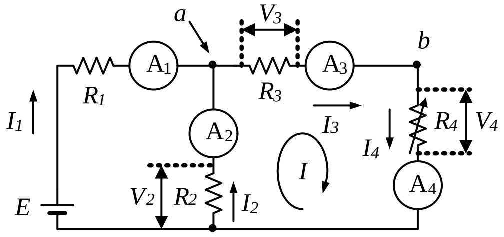


Fig. 2 Test Circuit

[Experimental procedure]

1. Circuit construction

- Connect the resistors R_1 to R_3 and the DC variable bench supply with a wiring cable, referring to Fig. 2. The circuit should be constructed taking into account that a rheostat should be connected to R_4 later, and a tester should be connected to A_1-A_4 and V_2-V_4. The voltage of the power supply should be 5V.

2. Setting of R_4 (measurement of resistance)

- Adjust the rheostat R_4 and measure the resistance value with a tester.

  (The rheostat R_4 shall be turned fully to the left and fully to the right, plus three points in between, for a total of five points, repeat steps 3 to 4 below.

3. Measurement of the current

- Connect R_4 to the circuit and connect the tester to the place where you want to measure the current (any of A_1 to A_4). At this point, pay attention to the polarity, considering the direction in which the current actually flows.
- After setting the tester to the appropriate current range, turn the power on.
- Read the current value with the tester and enter it in Table 1.

4. Measuring the voltage

- Turn off the power supply and connect the tester to the place where you want to measure the voltage (one of V_2 to V_4). At this point, pay attention to the polarity, considering the positive and negative of the voltage.
- After setting the tester to the appropriate DC voltage range, turn the voltage ON.
- Read the voltage value on the tester and record it in Table 1.
- Turn off the power supply and remove R_4 from the circuit, then go back to "Setting of R_4" and repeat the same procedure.

Table 1. Results of resistance measurement

R_4[Ω]	I_1[A]	I_2[A]	I_3[A]	I_4[A]	V_2[V]	V_3[V]	V_4[V]	State of R_4
								Turned fully to the left
								Turned fully to the right

4. Discussion

[1] For each measurement, consider whether the currents I_1 to I_4 at nodes *a* and *b* satisfy the first law of Kirchhoff's law.

[2] For each measurement, consider whether the voltages V_2 to V_4 in the closed circuit consisting of R_1 to R_4 satisfy Kirchhoff's second law.

Kirchhoff's Law (Lv.3)

1. Objective

Experiments to verify Kirchhoff's law, the Superposition theorem and Thevenin's law.

2. Theory

2.1 Kirchhoff's law

Current law: At any point in an electric circuit, the sum of the currents flowing into and out of that point is zero.

Voltage law: If we follow any electric closed circuit in one direction, the sum of the voltage drop and the sum of the electromotive forces in that closed circuit are equal.

2.2 Superposition theorem

The current flowing in each branch of a network containing two or more electromotive forces is equal to the sum of the currents in each branch calculated separately (superposition), assuming that each electromotive force exists alone in the network.

2.3 Thevenin's law

A circuit network can be represented by an equivalent circuit consisting of a voltage source V_0 and a resistor R_0 connected in series, regardless of its internal structure. Here, V_0 is the voltage between the terminals of the power supply circuit when it is open (open circuit voltage) and R_0 is the resistance between the terminals when it is short-circuited (short-circuit removal) by removing all the power supply in the circuit.

3. Experiment

3.1 Equipmental Setup & Materials

Tester
D.C. variable bench supply : 2 units
Fixed resistors 160Ω, 560Ω, 820Ω
Wiring Wire
Electric Clip

3.2 Experimental method

3.2.1 Superposition theorem

Construct a circuit as shown in Fig. 1 and measure the current at each point in the circuit. Furthermore, measure the current in the same way with no power supply on one side, as shown in Fig. 2 and Fig. 3. However, assume that R_1=560[Ω], R_2=560[Ω], R_3=560[Ω], E_1=8.8[V] and E_2=11.4[V].

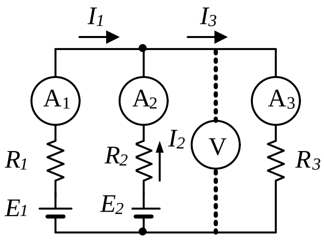


Figure 1

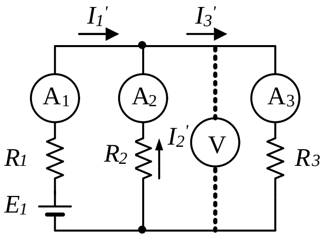
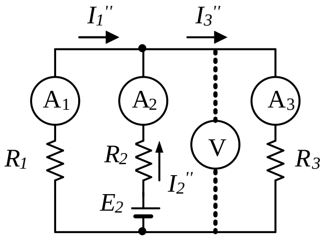


Figure 2



Fgure 3

[Experimental procedure]

- Measure the current of I_1 to I_3 with a tester.
- Remove E_2, short-circuit both ends (Fig. 2) and measure the current from I_1' to I_3' with a tester.
- Remove E_1, short-circuit both ends (Fig. 3) and measure the current from I_1'' to I_3'' with a tester.

3.2.2 Thevenin's law

Take the part of the circuit shown in Fig. 1 consisting of E_1, E_2, R_1 and R_2 as the power supply circuit and measure the voltage value in the open state with R_3 removed. Also, measure the resistance of the power supply circuit with the power supply removed. Based on these voltage and resistance values, construct an equivalent circuit for the power supply circuit and measure the current flowing through the circuit. The resistors R_1 to R_3 and the value of the electromotive force E should be the same as in the experiment in 1.

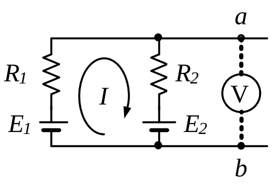


Figure 4

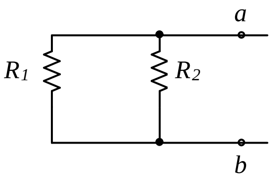
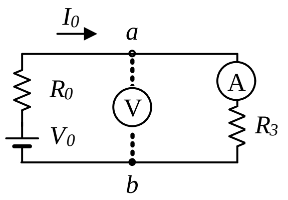


Figure 5



Fgure 6

[Experimental procedure]

- Measure the voltage V_0 between terminals *a* and *b* in Fig. 4 with a tester.
- Remove E_1 and E_2 and short-circuit them respectively to make the circuit of Fig. 5, and measure the resistance R_0 between terminals *a* and *b* with a tester.
- Make the circuit shown in Fig. 6 and measure the current I_0 with a tester. However, V_0 and R_0 should be the values obtained in the above measurement.

4. Discussion

[1] Compare the theoretical and measured values of the currents I_1~I_3, I_1' ~I_3' and I_1' ~I_3'', respectively, using Kirchhoff's law for the experiment of 1 Compare the theoretical values with the measured values.

[2] Show that the superposition theorem holds for the circuits shown in Fig. 2 and Fig. 3 of the experiment in 1 using the current values obtained in the experiment.

[3] Compare and discuss the measured and theoretical values of the resistance in Fig. 5 for the experiment of 2.

[4] In response to the experiment in 2, show that Fig. 6 is the same circuit as Fig. 1 (equivalent circuit), using Thevenin's law.

Basic of Sequential Control Circuits (Lv.1)

1. Objective

Acquire basic knowledge of Sequential Control Circuits. Make basic sequential control circuits wiring, programming or simulating sequential control circuits. Understanding sequence control by checking the operation of the sequence control circuit.

2. Theory

Sequence control is a control in which each stage of control operation is sequentially advanced according to a predetermined order. In this experiments, we will confirm the movement of sequential circuits using an electronic circuit simulator TINA and understand sequence control.

3. Experiment

3.1 Equipment Setup & Materials

Personal computer, TINA

3.1.1 Symbols of electric components used in TINA

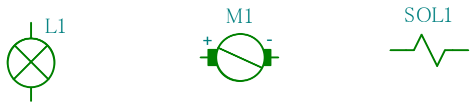
Fig.1 to Fig.3 shows symbols used in TINA.

Standard Circular Solenoid Make contact Brake contact Switching contact

Fig.1 Electromagnetic relay symbols used in TINA

Retention type make contacts Retention type switching contact Return type make contacts Return type brake contacts Return type switching contacts

Fig.2 Switch symbols used in TINA

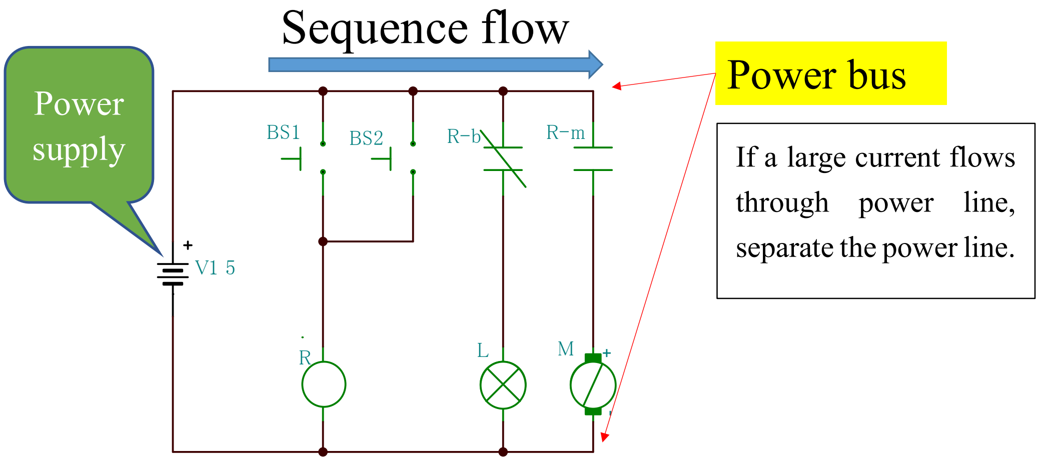


Lamp Motor Solenoid coil

Fig.3 Actuator symbols used in TINA

3.1.2 How to use TINA

Fig.4 shows example of switching circuits, vertical writing sequence diagram in TINA. If you write sequence control circuit using TINA, you have to place the power supply.



Sequence flow

Power supply

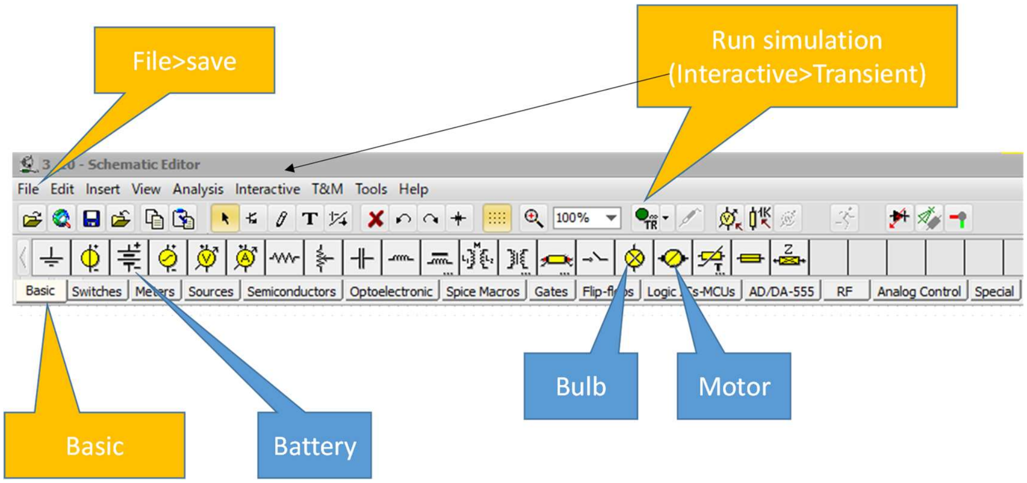
Power bus

If a large current flows through power line, separate the power line.

Fig.4 Example circuit vertical writing sequence diagram in TINA

3.1.3 Main menu shown at the top of the TINA

To perform various operations with TINA, select from the menu shown at the top of the screen.



File>save

Run simulation (Interactive>Transient)

Basic

Battery

Bulb

Motor

Fig.5 Save the file, Run the simulation and Selection of parts in TINA

3.1.4 Select switch

To select any parts with TINA, select form the menu shown at the top of the screen.

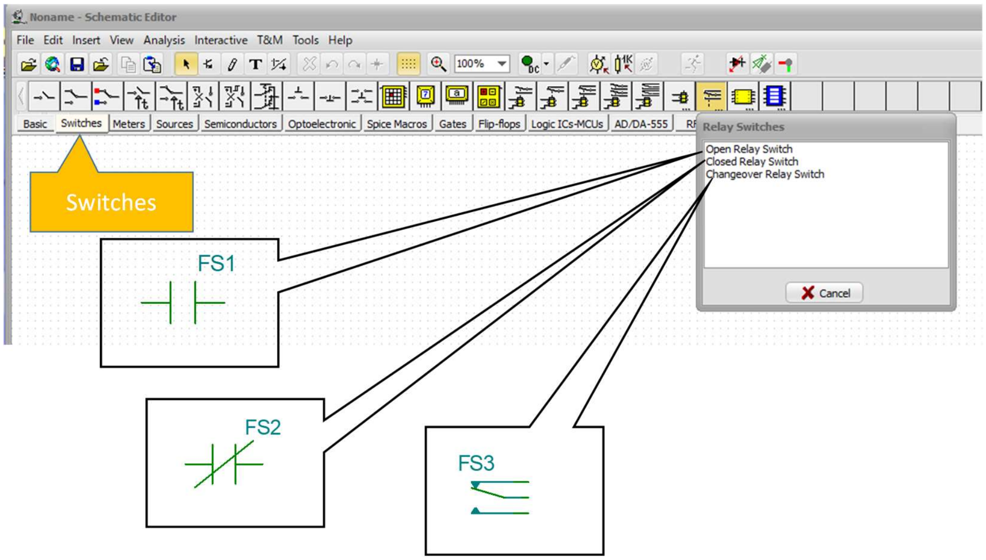


Fig.6 Select relay switch in TINA

3.1.5 Select relay coil

To select any parts with TINA, select form the menu shown at the top of the screen.

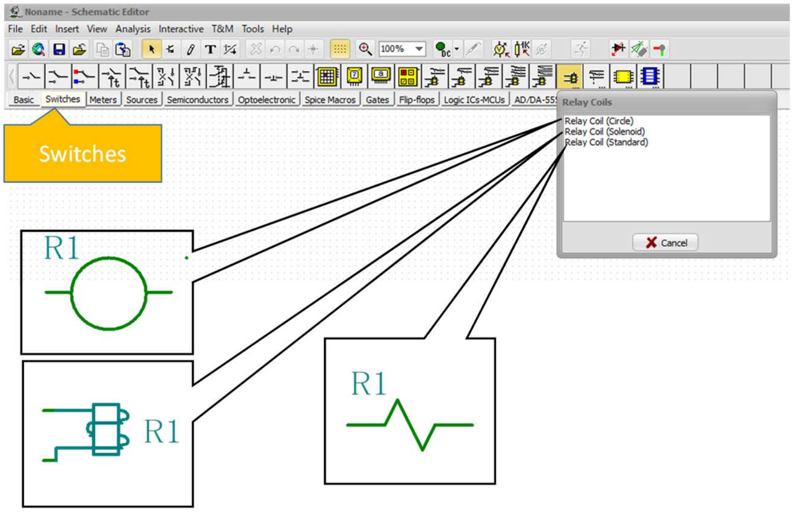


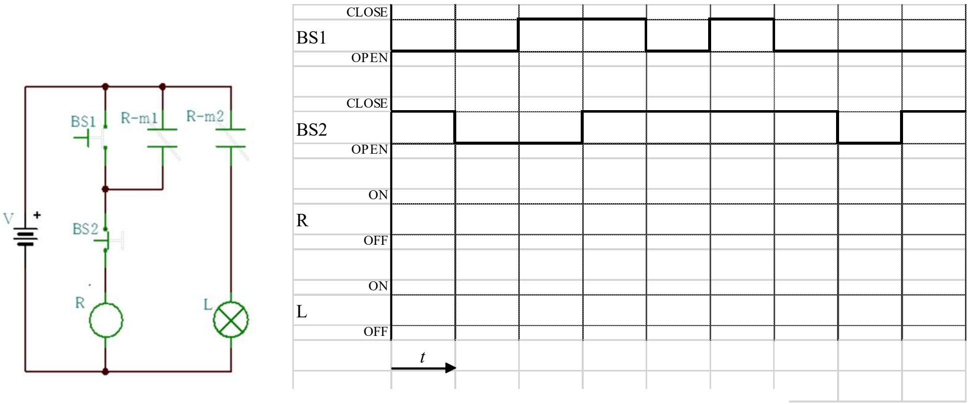
Fig.7 Select relay coil in TINA

3.2 Experiment (Simulation)

Write a sequential circuit using TINA. Create a folder for each program and store the program under the folder. Then simulate sequential circuit.

3.2.1 Reset input priority type Self Holding Circuit

Operate the sequence control circuit shown in Fig.8 and draw a time chart of R and L.



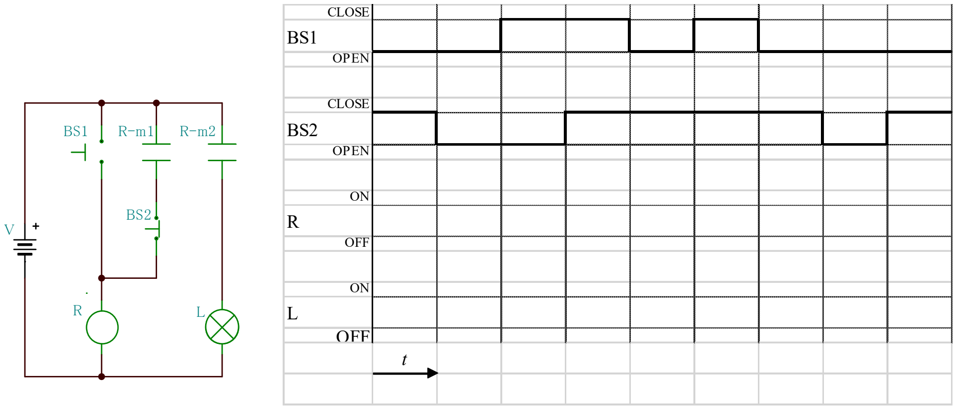
Set switch : BS1 Reset switch: BS2 Relay : R

Relay contacts : R-m1, R-m2 Output : L

Fig.8 Reset input priority type Self Holding Circuit

3.2.2 Set input priority type Self Holding Circuit

Operate the sequence control circuit shown in Fig.9 and draw a time chart of R and L.



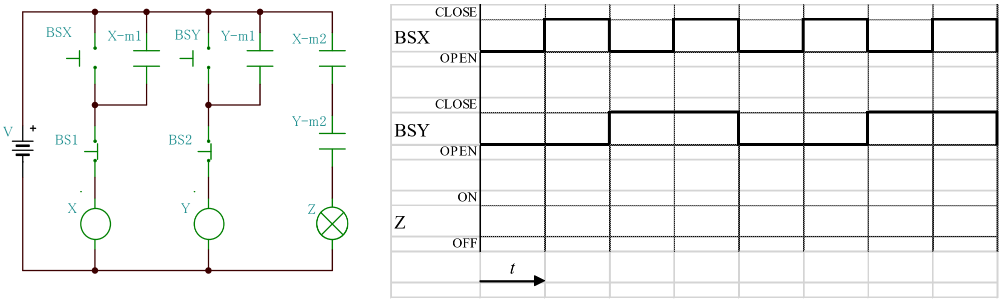
Set switch : BS1 Reset switch: BS2 Relay : R

Relay contacts : R-m1, R-m2 Output : L

Fig.9 Set input priority type Self Holding Circuit

3.2.3 And circuit

Operate the sequence control circuit shown in Fig.10 and draw a time chart of Z.

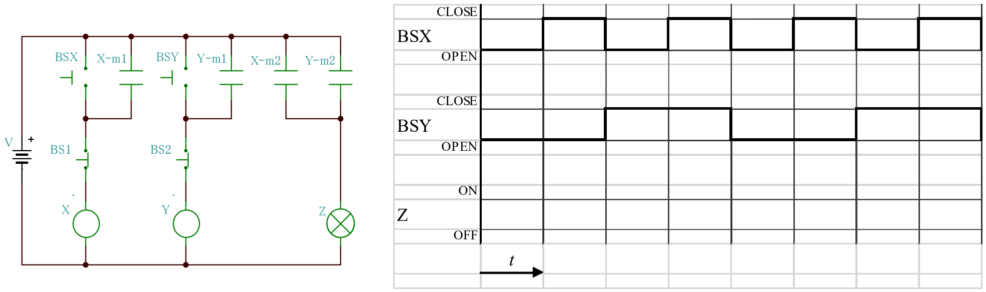


Set switch : BS1　Reset switch: BS2　Relay : R
Relay contacts : R-m1, R-m2　Output : L

Fig.10 AND Circuit

3.2.4 OR circuit

Operate the sequence control circuit shown in Fig.11 and draw a time chart of Z.

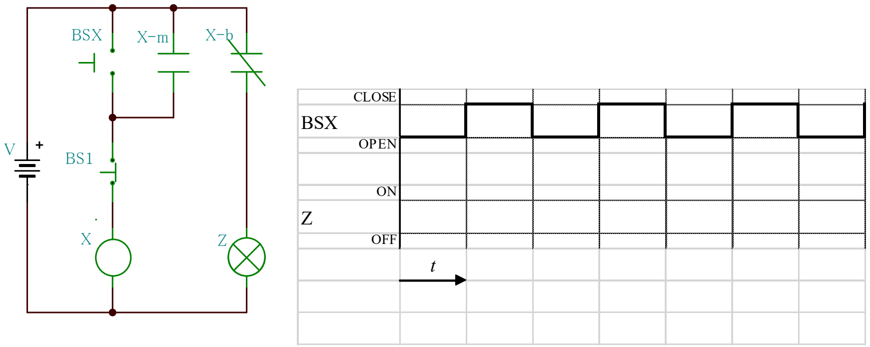


Set switch : BS1　Reset switch: BS2　Relay : R
Relay contacts : R-m1, R-m2　Output : L

Fig.11 OR Circuit

3.2.5 NOT circuit

Operate the sequence control circuit shown in Fig.12 and draw a time chart of Z.



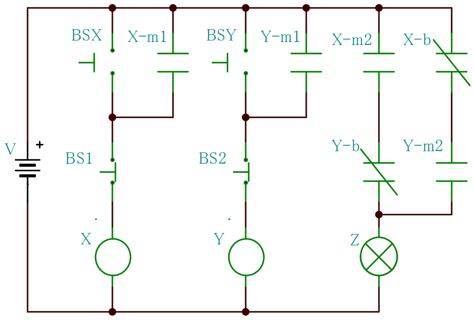
X switch : BSX Relay : X Relay contacts : X-m, X-b

Output : Z

Fig.12 NOT Circuit

3.2.6 EX-OR circuit

Operate the sequence control circuit shown in Fig.13 and draw a time chart of Z.



X switch : BSX

Y switch : BSY

Relay : X, Y

Relay contacts : X-m1, X-m2

Relay contacts : Y-m1, Y-m2

Relay contacts : X-b, Y-b

Output : Z

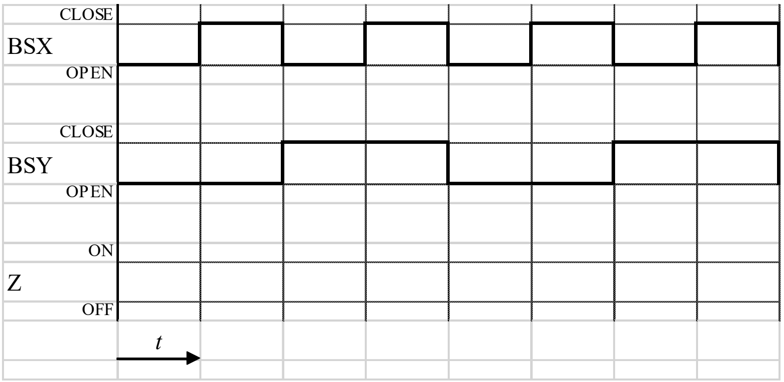


Fig.13 EX-OR Circuit

[Experimental procedure]

1. Circuit construction

- Make vertical writing sequence diagram in TINA. You have to place the power supply.
- Create folder for each subject to store the program.

2. Circuit simulation

- Run simulation. (Interactive>Transient)

3. Make time chart

- Make time chart from circuit operation, or using transient instruction.

3. Discussion

[1] Explain timed control method and condition control method.

Test a program to transfer the 16 bytes of data from ROM location staring at 30H to RAM (Lv.2)

1. Objectives

- To write a source program that accesses ROM/RAM in assembly language.
- To check contents and operation of the program with GNU Tools.

2. Theory

2.1 Memory space of AVR microcontroller and GCC

The AVR microcontroller (Atmega 328P) has a Harvard architecture which has SRAM and Flash memory to store data and instructions [1]. Therefore, as shown in Fig.1, memory space is divided into a data space for accessing data and a program memory space for accessing instructions. Both spaces have addresses starting from address 0. Instructions for accessing data and program memory space are different [2]. On the other hand, the GNU compiler can handle the data space and the program space as the same memory space. The address is extended by 1 byte to distinguish the data spaces from program memory spaces. In the program memory space, 0x00 is added as the upper byte. In the data space, 0x80 is added as the upper 1 byte of the address. The address space allocated to SRAM (2k byte) is from 0x800100 to 0x8008FF.

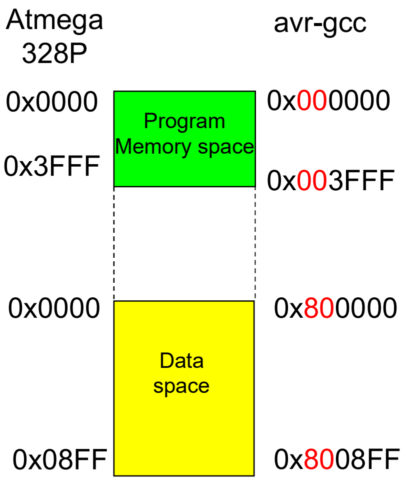


Fig. 1 Memory space of AVR and GCC

2.2 Pseudo instructions and definition of symbols in assembly language

The source code in assembly language is a mixture of two instructions, one that is translated into machine language and another that is a pseudo-instruction for assemblers and linkers. Pseudo instruction can define symbols such as a branch destination. For example, by using a label ”x” and the special symbol ‘.’ refers to the current address in Fig. 2, it is possible to define the name "size_x" indicating the size of

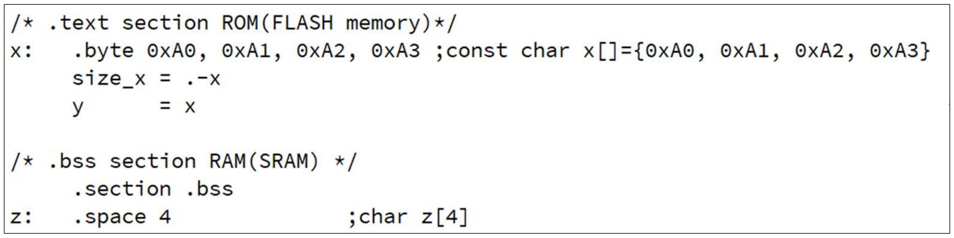
```
x:    .byte 0x00, 0x01, 0x02, 0x03
      size_x = .-x
      y      = x
```

Fig. 2 Example of symbols

the data array char x[4]. Similarly, a new symbol "y" can be defined by using the symbol x. The name such as x, size_x and y can also be referenced from the linker and other source files.

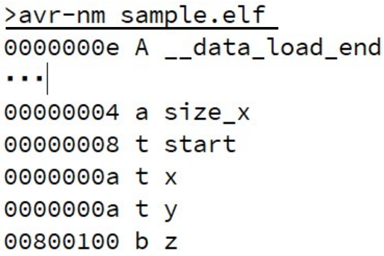
2.3 Check the name definition using the nm command

The defined symbol can be confirmed from the nm command, which is one of the GNU Tools. For example, the name defined in the executable file obtained by assembling the source file shown in the Fig. 3 can be displayed in nm. The Fig. 4 shows the names in the executable file using the avr-nm command. The first column is the value associated with the name. The value is either a number or an address. The second column shows the attributes. Lowercase letters indicate that the name can only be referenced within a local file. The third column shows the name.



```
/* .text section ROM(FLASH memory)*/
x:   .byte 0xA0, 0xA1, 0xA2, 0xA3 ;const char x[]={0xA0, 0xA1, 0xA2, 0xA3}
     size_x = .-x
     y      = x

/* .bss section RAM(SRAM) */
     .section .bss
z:   .space 4             ;char z[4]
```

Fig. 3 Sample program



```
>avr-nm sample.elf
0000000e A __data_load_end
...
00000004 a size_x
00000008 t start
0000000a t x
0000000a t y
00800100 b z
```

Fig. 4 How to use avr-nm command

3. Experiment

3.1 Software, PC, document and skill required for the experiment

- Gnu toolchain: “AVR-GCC 11.1.0 for Windows 32 and 64 bit”
  URL of download https://blog.zakkemble.net/avr-gcc-builds/
- PC (windows 10 later)
- Hardware manual on AVR microcontroller: Reference [1]
- Instruction manual on AVR: Reference [2]
- Basic operation skill on GDB (command: breakpoint, si, c, print, display, x and so on)

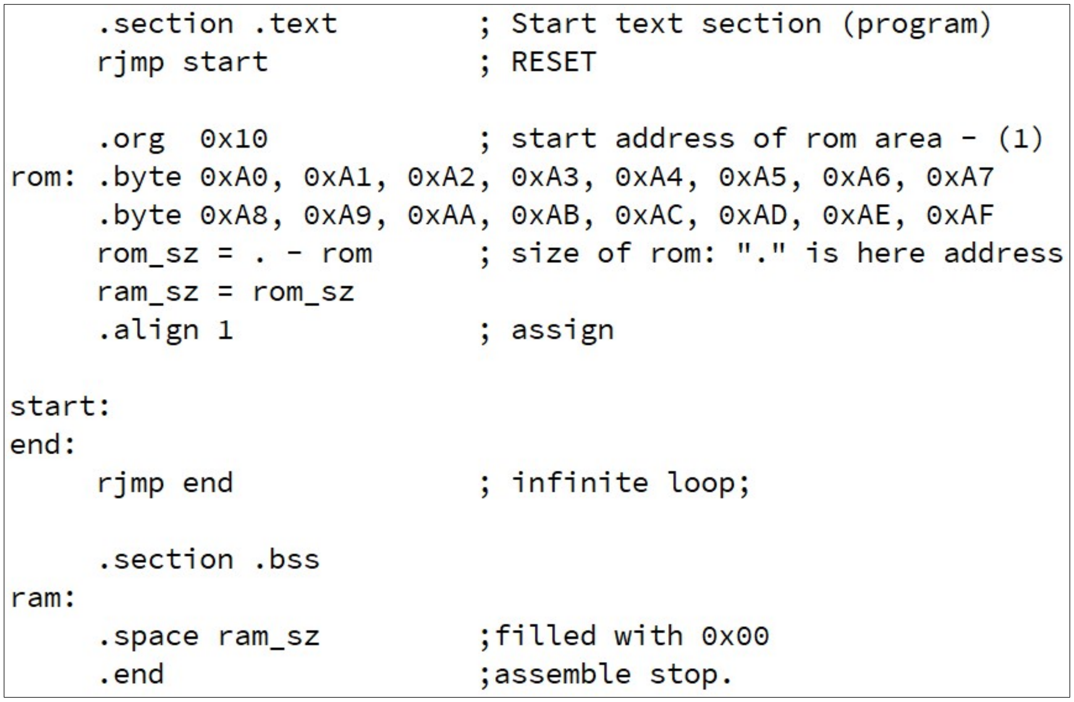
- Basic operation skill on making executable file with avr-gcc and avr-ld through compile and link.

3.2 Experiment

3.2.1 Define storage area in ROM and RAM

In this experiment:

- Define a data area in the ROM area (Flash memory area) and RAM area.
- Check the name defined with the pseudo-instruction by using avr-nm. Fig.5 shows the program (exercise 01-1.S).



```
     .section .text         ; Start text section (program)
     rjmp start             ; RESET

     .org  0x10             ; start address of rom area - (1)
rom: .byte 0xA0, 0xA1, 0xA2, 0xA3, 0xA4, 0xA5, 0xA6, 0xA7
     .byte 0xA8, 0xA9, 0xAA, 0xAB, 0xAC, 0xAD, 0xAE, 0xAF
     rom_sz = . - rom       ; size of rom: "." is here address
     ram_sz = rom_sz
     .align 1               ; assign

start:
end:
     rjmp end               ; infinite loop;

     .section .bss
ram:
     .space ram_sz          ;filled with 0x00
     .end                   ;assemble stop.
```

Fig. 5 Exercise 01-1.S

1) Compile and link the program in Figure 5 (exercise 01-1.S) with avr-gcc and avr-ld to make an executable. Confirm the names in the executable file with avr-nm command. By the output of avr-nm, fill the blanks in table 1.

Table 1 Names in the excitable file

Contents	Name	Value/Address
Data address on ROM	rom	
Size of data on ROM	rom_sz	

Data address on RAM	ram	
Data address on ROM	ram_sz	

2) Line with "- (1)" of Fig. 5 indicates that the ROM address is 0x10 from the beginning of the ROM. Change this value from 0x10 to 0x30. After creating the executable file in the same way as explained in 1), use the avr-nm command to find out the name. Enter the result in the blank of Table 2.

Table 2 Result of the modified program

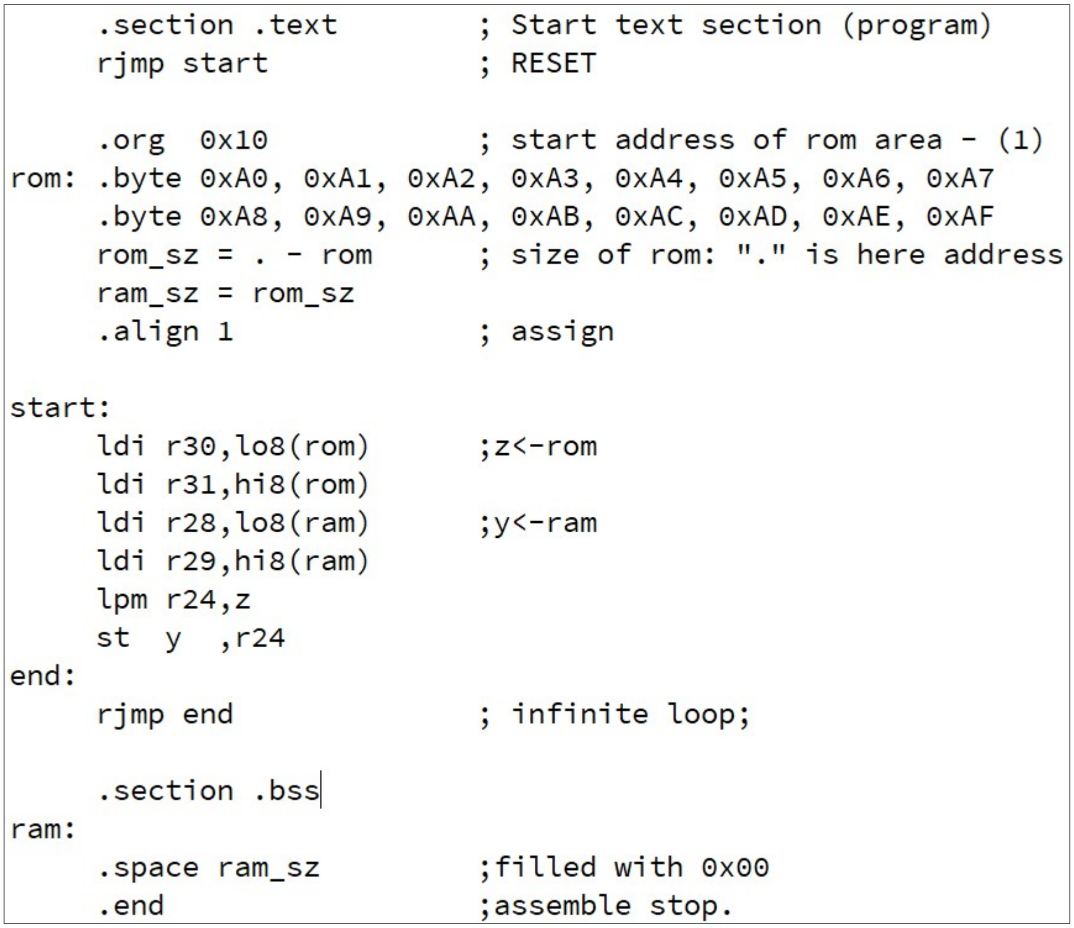
Contents	Name	Value/Address
Data address on ROM	rom	
Size of data on ROM	rom_sz	
Data address on RAM	ram	
Data address on ROM	ram_sz	

3.2.2 Access to ROM and RAM area

In this experiment, we try to read data from the ROM area and RAM area.
As mentioned in Section 2.1, the AVR microcomputer has a program memory space and a data space separately. Therefore, the instructions for reading data from the program memory space and the data space are different[2].

- Data space: “LD” instruction (Load data form Data space with direct / indirect / immediate Addressing)
- Program memory space: “LPM” instruction (Load data from Program memory space with indirect Addressing)

1）Compile and link the program (exercise 01-2.S) to create an executable file.
Verify the operation of the executable file using GDB. Make sure that the ROM value 0xA0 is copied to RAM (address: 0x800110). Capture the screen of the result of GDB execution and report the result.



```
     .section .text        ; Start text section (program)
     rjmp start            ; RESET

     .org  0x10            ; start address of rom area - (1)
rom: .byte 0xA0, 0xA1, 0xA2, 0xA3, 0xA4, 0xA5, 0xA6, 0xA7
     .byte 0xA8, 0xA9, 0xAA, 0xAB, 0xAC, 0xAD, 0xAE, 0xAF
     rom_sz = . - rom      ; size of rom: "." is here address
     ram_sz = rom_sz
     .align 1              ; assign

start:
     ldi r30,lo8(rom)      ;z<-rom
     ldi r31,hi8(rom)
     ldi r28,lo8(ram)      ;y<-ram
     ldi r29,hi8(ram)
     lpm r24,z
     st  y  ,r24
end:
     rjmp end              ; infinite loop;

     .section .bss
ram:
     .space ram_sz         ;filled with 0x00
     .end                  ;assemble stop.
```

Fig. 6 Exercise 01-2.S

3.2.3 Copy the 16 bytes of data from ROM location staring at 10H to RAM(0x800100)

Fig. 7 is a flowchart of the procedure for copying 16-byte data located in ROM (starting to address 0x30) to RAM. The actual coded source program is shown in Fig.8. The program in Fig. 8 is a modification of exercise 01-2.S shown in Fig.6.

Fill in the blanks (①-④) in Fig.8 based on the flowchart in Fig. 7. Then, verify the operation of the program with GDB and show that the data is copied to RAM.

Explain the results by showing capture of the screen displayed with GDB in the report.

(Flowchart description)

R25: Counter of loop

R26: The number of data

Conditional branch: Refer to table 3

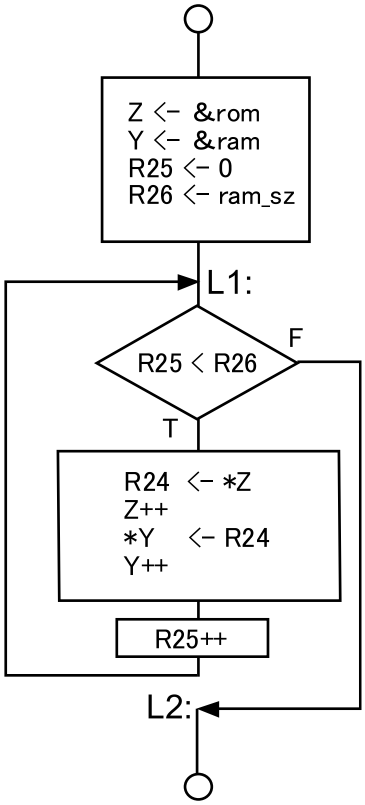


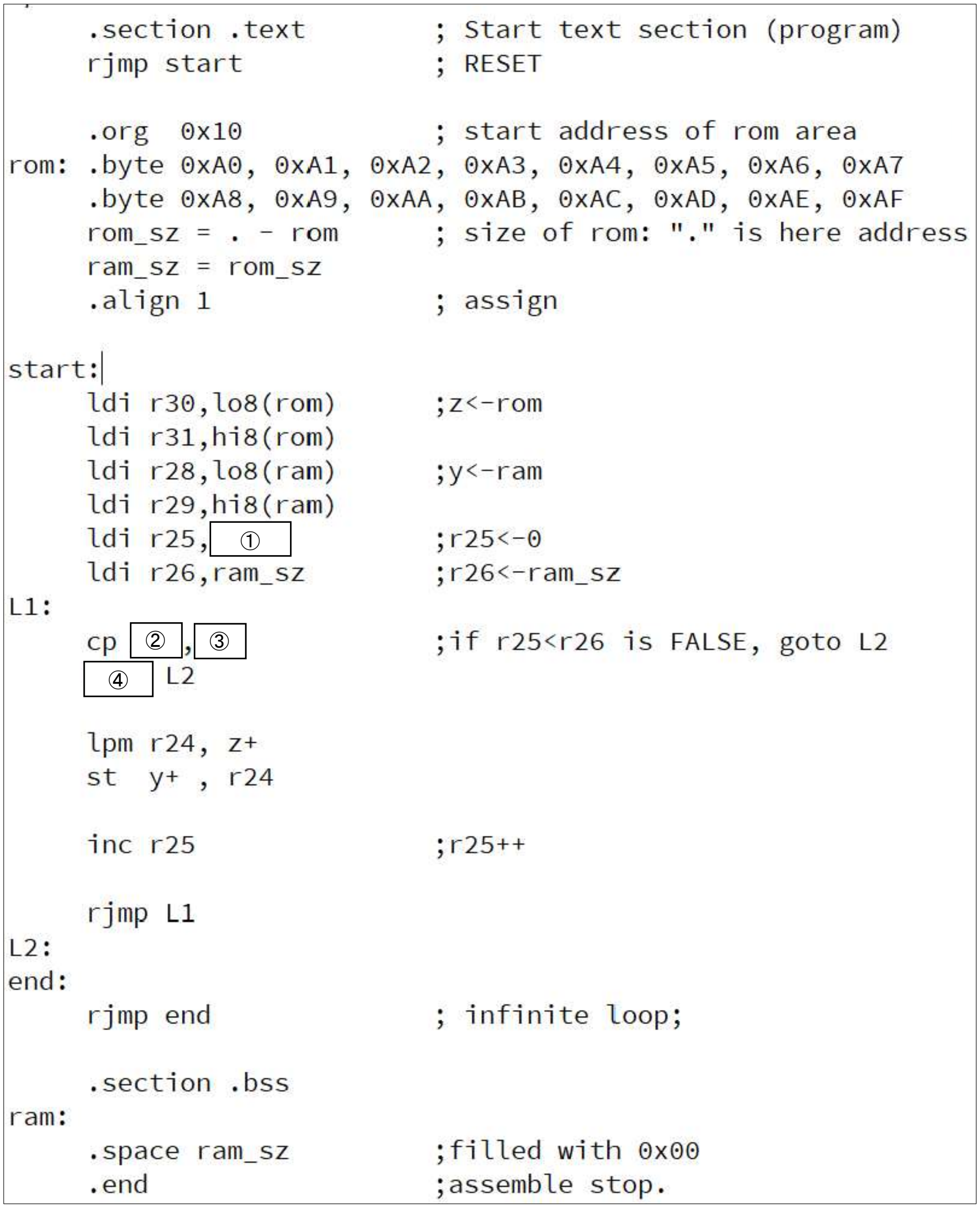
Fig. 7 Flowchart of copying data from ROM to RAM

Table 3 Conditional branch

comparison operator □ Rd□Rs	mnemonic	
	Branch with TRUE	Branch with FALSE
>	brlc *	brsh *
>=	brcc	brscs
=	breq	brne
!=	brne	breq
<=	brsh *	brlo *
<	brscs	brcc

*; Condition is made by reversing Rd and Rs.

cp Rd, Rs-> cp Rs, Rd



```
     .section .text          ; Start text section (program)
     rjmp start              ; RESET

     .org  0x10              ; start address of rom area
rom: .byte 0xA0, 0xA1, 0xA2, 0xA3, 0xA4, 0xA5, 0xA6, 0xA7
     .byte 0xA8, 0xA9, 0xAA, 0xAB, 0xAC, 0xAD, 0xAE, 0xAF
     rom_sz = . - rom        ; size of rom: "." is here address
     ram_sz = rom_sz
     .align 1                ; assign

start:
     ldi r30,lo8(rom)        ;z<-rom
     ldi r31,hi8(rom)
     ldi r28,lo8(ram)        ;y<-ram
     ldi r29,hi8(ram)
     ldi r25, ①              ;r25<-0
     ldi r26,ram_sz          ;r26<-ram_sz
L1:
     cp  ② , ③               ;if r25<r26 is FALSE, goto L2
     ④  L2

     lpm r24, z+
     st  y+ , r24

     inc r25                 ;r25++

     rjmp L1
L2:
end:
     rjmp end                ; infinite loop;

     .section .bss
ram:
     .space ram_sz           ;filled with 0x00
     .end                    ;assemble stop.
```

Fig. 8 Program for copying from ROM to RAM

4. Discussion

(1) The type of data placed in ROM was unsigned char. Consider a program whose data type is unsigned int (2 bytes).

(2) Examine the instructions for accessing ROM (flash memory) space and RAM space, based on reference [2].

(3) There are .rodata. and dataas well as .text and .bss . Examine the differences between the four sections (.text, .bss, .data, .rodata) from the two view points of allocation area (ROM / RAM) and attribute (read / write).

(4) Examine the program that transfers the data in the .data section into the RAM space.

(5) In this experiment, we used the nm command (avr-nm). In addition, there are objdump commands (avr-objdump) and size commands (avr-size) for investigating objects and executable programs. Examine the functionality of the objdump and size commands.

5. Reference

[1] Microchip ATmega48A/PA/88A/PA/168A/PA/328/P megaAVR® Data Sheet
[2] Microchip AVR® Instruction Set Manual

Title: Measurement of Head Loss/Frictional Loss in a Pipeline

1. Background

A pipeline is a circular conduit used to convey process fluid from one location in the system to another. A pipeline consists of a circular pipe full of fluid, the process fluid, and the valves and fittings used to direct the flow of fluid through the pipe in the operation. Each of these items affects the head loss in the pipeline. Most fluids used in industrial applications are Newtonian, meaning that their viscosity does not change with the rate of flow. Water, oils, solvents and petroleum products are examples of Newtonian fluids. For simplification this discussion will be limited to the flow of Newtonian fluids through circular pipelines.

1.1 Objective

The main objective of this experiment is to measure the head loss/ friction loos in pipes.

2. Theory

When a gas or a liquid flows through a pipe, the flow of fluid through a pipe is resisted by viscous shear stresses within the fluid and the turbulence that occurs along the internal pipe wall. This friction converts some of the fluid's hydraulic energy to thermal energy. This thermal energy cannot be converted back to hydraulic energy, so the fluid experiences a drop in pressure. In other words, due to this there will be a loss of pressure in the fluid, because energy is required to overcome the viscous or frictional forces exerted by the walls of the pipe on the moving fluid. In addition to the energy lost due to frictional forces, there will be a loss in energy when the fluid flows through fittings, such as valves, elbows, contractions and expansions. This loss in pressure is mainly due to the local flow separation as it moves through such fittings. The pressure loss in pipe flows is commonly referred to as ***head loss***. The frictional losses are mainly caused in a straight pipe, friction loss induced in fittings, such as bends, couplings, valves, or transitions in hose or pipe accounts for minor losses. The frictional losses are referred to as ***major losses (h_f)*** while losses through fittings, etc, are called ***minor losses (h_m)***. Together they make up the ***total head losses (h)*** for pipe flows.

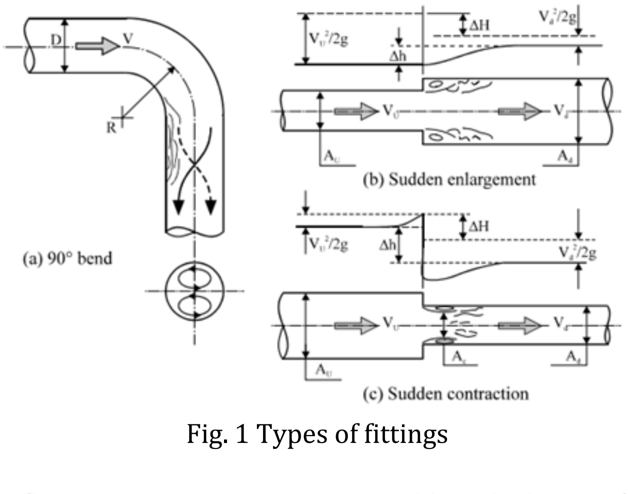
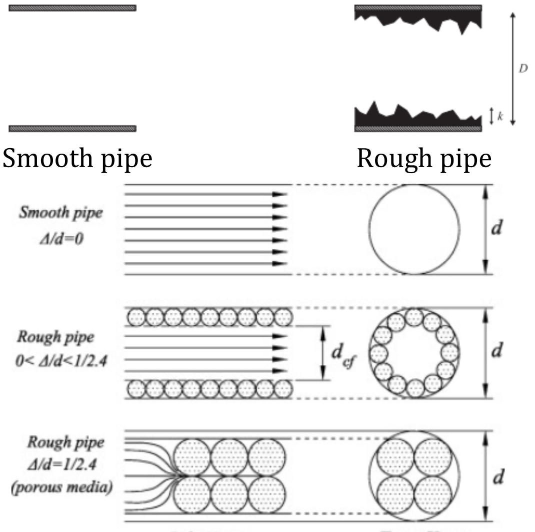


Fig. 1 Types of fittings

In practice, loss in a pipe flow comes into picture in cases like calculation of rate of flow in the pipes connecting two reservoirs at different levels or to calculate the additional head required to double the rate of flow along an existing pipeline. These pipe losses are dependent on number of factors like viscosity of the fluid, the size of the internal pipe diameter, the internal roughness of the inner surface of the pipe, the change in elevation between the ends of the pipe, material of the pipe and the length of the pipe along which the fluid travels.



(Source: Haung et al 2013)

Fig. 2 Internal surface of smooth and rough pipes

Pipes with smooth surface does not account for larger friction loss, whereas pipes with less smooth walls such as concrete, cast iron and steel fluid requires large energy to overcome the friction induced in a pipe due to the viscosity of liquid. Rougher the inner wall of the pipe, more will be the pressure loss due to friction.

2.1 Friction loss in pipe

The friction loss in a uniform, straight sections of pipe, known as "major loss", is caused by the effects of viscosity, the movement of fluid molecules against each other or against the (possibly rough) wall of the pipe. Here, it is greatly affected by whether the flow is laminar or turbulent.

Laminar Flow: It occurs when the fluid flows in parallel layers without adjacent mixing between the layers. In this type of flow there are neither eddies nor cross currents, with fast flow over the center part of the pipe and no movement near the pipe surface. The roughness of the pipe surface influences neither the fluid flow nor the friction loss. For laminar flow Reynolds's number (R_e) < 2100.

Turbulent Flow: It occurs when the liquid is moving fast with mixing between layers. The speed of the fluid at a point continuously undergoes changes in both magnitude and direction. For turbulent flow Reynolds's number $2100 < R_e < 4000$.

Transitional flow: is a mixture of laminar and turbulent flow, with turbulence flow in the center of the pipe and laminar flow near the edges of the pipe. Each of these flows behaves in different manners in terms of their frictional energy loss while flowing and have different equations that predict their behavior. For transitional flow Reynolds's number $R_e > 4000$.

It is useful to characterize that roughness as the ratio of the roughness height k to the pipe diameter D, the "relative roughness". Three sub-domains pertain to turbulent flow:

- In the smooth pipe domain, friction loss is relatively insensitive to roughness.
- In the rough pipe domain, friction loss is dominated by the relative roughness and is insensitive to Reynolds number.
- In the transition domain, friction loss is sensitive to both.

The Darcy Equation is a theoretical equation that predicts the frictional energy loss in a pipe based on the velocity of the fluid and the resistance due to friction. It is used almost exclusively to calculate head loss due to friction in turbulent flow.

$$h_f = \frac{f L v^2}{2Dg}$$

Where:

- h_f = Friction head loss
- f = Darcy resistance factor
- L = Length of the pipe
- D = Pipe diameter
- v = Mean velocity
- g = acceleration due to gravity

In turbulent flow, the friction factor, f depends upon the Reynolds number and on the relative roughness of the pipe, k/D, where, k is the roughness parameter and D is the inner diameter of the pipe. When k is very small compared to the pipe diameter D i.e., k/D > 0, f depends only on R_e. When k/D is a significant value, at low R_e, the flow can be considered as in smooth regime (no effect of roughness). As R_e increases, the flow becomes transitionally rough, called as transition regime in which the friction factor rises above the smooth value and is a function of both k and R_e and R_e increases more and more the flow eventually reaches a fully rough regime in which f is independent of R_e. For design purposes, the frictional characteristics of round pipes, both smooth and rough are summarized by the friction factor chart, which is a log-log of fanning friction factor vs R_e which is based on Moody's chart.

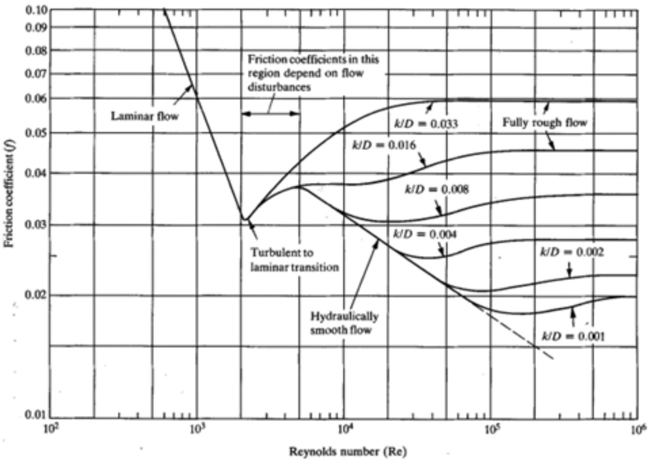
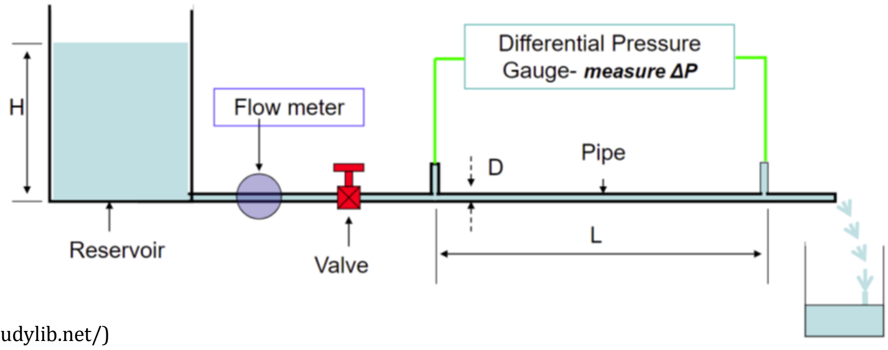


Fig. 3 Moody's chart

3. Experiment

3.1 Experimental Setup & Materials

Figure 4 shows the schematic view of the experimental setup, and the following materials are required to conduct the experiment.



(source: https://studylib.net/)

Fig. 4 Schematics of the experimental setup

1. A small aquarium pump
2. A funnel
3. 2 plastic tubs with straight sides
4. A small tube of silicone sealant
5. A binder clip
6. A short length of tubing to connect to the pump
7. Straw construction kits
8. Tape measure and calipers
9. Measuring cylinder and stopwatch

3.2 Procedure

The experiment can be conducted following the procedure given below.

1. Measure the internal diameter (D) of the straws.
2. Build a horizontal pipe with piezometers at the start and immediately before and after each bend.
3. Connect the start of the pipe to the upper constant head tank and the end drain into the overflow tank.
4. Fill the constant head tank and turn on the pump so that water flows along the pipe and also recirculates within the constant head tank system.
5. Measure the height of water in each of the piezometer tubes and the length of each pipe section.
6. Use the measuring cup to capture a known volume of water over a measured time and calculate the volume flow rate.
7. Calculate the average velocity in the pipe ($U=Q/A$) and Reynolds number ($Re=UD/\nu$).
8. Calculate the head loss h_{fP} along each section of pipe based on the change in piezometer height measurements.
9. Calculate the head loss around the bend (h_{fB}) based on the difference in piezometer heights.
10. Calculate the friction factor for the pipe ($f=h_{fp}D^2g/U^2L$) (based on the Darcy-Weisbach equation)
11. Calculate the loss coefficients for the various bends ($K_l=h_{fB}{}^2g/U$).
12. Compare the pipe friction factor (f) and local loss coefficient (K_l) to standard values.

4. Results

The result of distances obtained from the experiment is to be presented graphically or in tabular form, and compare with the theoretical results.

5. Discussion

Make a discussion on the experiment and the results obtained, such as friction loss, bending loss.

6. Conclusion

Make a brief conclusion.

References

1. Miller, R. W., Flow Measurement Engineering Handbook, Second Edition, McGraw-Hill, 1989.
2. Fox and McDonald, Introduction to Fluid Mechanics, Wiley, 2011.

Title: **Experiment on the Measurement of Surface Tension with an One Yen/paisa Coin**

1. Introduction

Surface tension is the tendency of liquid surfaces to shrink into the minimum surface area possible. Surface tension allows insects (e.g. water striders), usually denser than water, to float and slide on a water surface, as shown in Fig. 1.

Fig. 1 Water striders stay atop the liquid because of surface tension

At liquid–air interfaces, surface tension results from the greater attraction of liquid molecules to each other (due to cohesion) than to the molecules in the air (due to adhesion). The net effect is an inward force at its surface that causes the liquid to behave as if its surface were covered with a stretched elastic membrane. Thus, the surface comes under tension from the imbalanced forces, which is probably where the term "surface tension" came from. Because of the relatively high attraction of water molecules to each other through a web of hydrogen bonds, water has a higher surface tension (72.8 millinewtons per meter at 20°C) than most other liquids. Surface tension is an important factor in the phenomenon of capillarity.

Surface tension has the dimension of force per unit length, or of energy per unit area. The two are equivalent, but when referring to energy per unit of area, it is common to use the term surface energy, which is a more general term in the sense that it applies also to solids. In materials science, surface tension is used for either surface stress or surface energy.

Surface tension can be a neat effect to observe, but it can also pose a problem. When we wash things like clothing or dishes, water needs to be able to fit into all the tiny cracks between clothing fibers, or between bits of food encrusted on a plate. This means we need to reduce the surface tension of water. Things that reduce surface tension are called surfactants. In this work, we will put droplets of water on an one yen or, one pasia coin. The higher the surface tension of the water, the bigger a droplet you can make before it breaks and flows over the edges of the coin. What do you think will happen when we add soap to the water? Let's try this experiemnt to find out!

1.1 Objective

The main objective of this experiment is to measure the surface tension with an one yen/paisa coin. Moreover, to compare the surface tension with the water mixed with surfactants.

2. Experiment

2.1 Experimental Setup & Materils

The following materials are required to conduct the experiment.

- Tap water
- Dish soap
- Drinking glasses, cups, or small bowls (2)
- Spoon
- Tray
- 1 cc syringes (2)
- One yen or, paisa coin
- Paper towel or dish towel
- Lab notebook

2.2 Procedure

1. Create a table in your lab notebook like Table 1, which you will use to record your data.

Table 1: Data table to record the results

Type of water	Milliliters of water until drop breaks [ml or, cc]			
	Try I	Try II	Try II	Average
Regular water				
Soapy water				

2. Fill one clean glass, cup, or small bowl with tap water.
3. Fill a second clean glass, cup, or small bowl with tap water. Pour in a few drops of dish soap and mix gently with a clean spoon.
4. Insert the tip of a syringe into the glass of plain tap water.
5. Pull up on the plunger of the syringe until the water in the syringe reaches the 1.0 mL mark. If you get too much, just squeeze some back into the glass by pushing down on the plunger and try again.
6. Place your coin on a flat, level surface where you can easily clean up a small amount of water, like on a kitchen counter.
7. Hold the tip of the syringe over the center of the coin. *Slowly* press down on the plunger, allowing one drop of water at a time to fall onto the coin.
8. Watch the coin very carefully. The drop of water forming on top of the coin will gradually get larger. Stop pushing on the plunger as soon as the drop spills over the edge of the coin.
9. Now, look at how much water is left in your syringe. Record the value left in your syringe in your lab notebook.
10. Calculate how much water you pushed out of the syringe by subtracting this value from 1.0 mL, and record this value in your data table for "Trial 1." Use Eqn. 1 to do the calculation:

Equation 1:

Amount of water pushed out of syringe = 1.0 mL - amount of water left in syringe

For example, with 0.3 mL left, that means 1.0 mL - 0.3 mL = 0.7 mL were pushed out of the syringe.

11. Completely dry off your coin and the surrounding surface with a towel.
12. Repeat steps 4–11 two more times, for your second and third trials with tap water. Remember to fill in your data table each time.
13. Using a new syringe, repeat steps 4–11 three times with the soapy water. Remember to completely dry off the coin between each trial, and record all your results in your data table.
14. Calculate an average of your three trials for the plain water and soapy water. Do this by adding the values for the three trials and then dividing by 3. For example, if your values for the plain tap water were 0.7 mL, 0.9 mL, and 0.95 mL, the average would be (0.7 + 0.9 + 0.95) ÷ 3 = 0.85 mL.

3. Results

The results is to be presented graphically or in tabular form, and compare.

1. Make a bar graph of your results.
2. Put the type of water (plain or soapy) on the x-axis (horizontal line).
3. Put the average mL of water when the drop broke on the y-axis (vertical line).
4. Based on the size of the droplets, do you think adding soap increased or decreased the surface tension of the water? Make a discussion.

4. Discussion

Make a discussion on the experiment and the results obtained.

5. Conclusion

Make a brief conclusion.

References

[1] Fox and McDonald, Introduction to Fluid Mechanics, Wiley, 2011.
[2] Surface Tension (Water Properties) – USGS Water Science School. US Geological Survey. July 2015. Retrieved November 6, 2015.
[3] https://www.britannica.com/science/
[4] https://en.wikipedia.org/wiki/

Title: **Determination of Buoyancy and Density using the Archimedes' principle**

1. Introduction

Buoyancy or upthrust, is an upward force exerted by a fluid that opposes the weight of an immersed object. In a column of fluid, pressure increases with depth as a result of the weight of the overlying fluid. Thus the pressure at the bottom of a column of fluid is greater than at the top of the column. Similarly, the pressure at the bottom of an object submerged in a fluid is greater than at the top of the object. The pressure difference results in a net upward force on the object. The magnitude of the force is proportional to the pressure difference, and (as explained by Archimedes' principle) is equivalent to the weight of the fluid that would otherwise occupy the volume of the object, i.e. the displaced fluid.

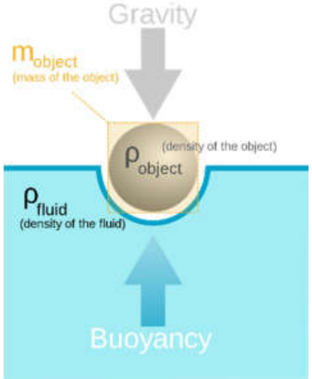


Fig.1 The forces at work in buoyancy. The object floats at rest because the upward force of buoyancy is equal to the downward force of gravity.

For this reason, an object whose average density is greater than that of the fluid in which it is submerged tends to sink. If the object is less dense than the liquid, the force can keep the object afloat. This can occur only in a non-inertial reference frame, which either has a gravitational field or is accelerating due to a force other than gravity defining a "downward" direction. The center of buoyancy of an object is the centroid of the displaced volume of fluid.

1.1 Archimedes' principle

Archimedes' principle is named after Archimedes of Syracuse, who first discovered this law in 212 BC. For objects, floating and sunken, and in gases as well as liquids (i.e. a fluid), Archimedes' principle may be stated thus in terms of forces:

> *Any object, wholly or partially immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object*

–with the clarifications that for a sunken object the volume of displaced fluid is the volume of the object, and for a floating object on a liquid, the weight of the displaced liquid is the weight of the object.

> More tersely: **buoyancy = weight of displaced fluid**.

Archimedes' principle does not consider the surface tension (capillarity) acting on the body, but this additional force modifies only the amount of fluid displaced and the spatial distribution of the displacement, so the principle that *buoyancy = weight of displaced fluid remains valid*.

The weight of the displaced fluid is directly proportional to the volume of the displaced fluid (if the surrounding fluid is of uniform density). In simple terms, the principle states that the buoyancy force on an object is equal to the weight of the fluid displaced by the object, or the density of the fluid multiplied by the submerged volume times the gravitational acceleration, g. Thus, among completely submerged objects with equal masses, objects with greater volume have greater buoyancy. This is also known as upthrust.

Suppose a rock's weight is measured as 10 newtons when suspended by a string in a vacuum with gravity acting upon it. Suppose that when the rock is lowered into water, it displaces water of weight 3 newtons. The force it then exerts on the string from which it hangs would be 10 newtons minus the 3 newtons of buoyancy force: 10 − 3 = 7 newtons. Buoyancy reduces the apparent weight of objects that have sunk completely to the sea floor. It is generally easier to lift an object up through the water than it is to pull it out of the water.

Assuming Archimedes' principle to be reformulated as follows,

$$\text{apparent immersed weight} = \text{weight} - \text{weight of displaced fluid}$$

then inserted into the quotient of weights, which has been expanded by the mutual volume

$$\frac{\text{density}}{\text{density of fluid}} = \frac{\text{weight}}{\text{weight of displaced fluid}}$$

yields the formula below. The density of the immersed object relative to the density of the fluid can easily be calculated without measuring any volumes.:

$$\frac{\text{density of object}}{\text{density of fluid}} = \frac{\text{weight}}{\text{weight} - \text{apparent immersed weight}}$$

(This formula is used for example in describing the measuring principle of a dasymeter and of hydrostatic weighing.)

1.2 Objective

The main objective of this experiment is to measure the buoyant force of different immersed objects, and then, to measure the density of an irregularly shaped object. Moreover, to determine the density of unknown liquid by using the using Archimedes' principle.

2. Experiment

2.1 Experimental Setup & Materils

The following materials are required to conduct the experiment.

- Tap water
- Tray
- Spring balance
- Beaker
- Rocks (light and dark)
- Sewing string
- Brass and steel weight /short metal cylinders
- Vernier caliper
- Unknown liquid
- Paper towel or dish towel
- Lab notebook

2.2 Procedure

I. Determination of metal density by direct measurement of volume and mass.

1. Using the pan balance, determine and record the mass of the metal cylinder provided.
2. Use the vernier caliper to measure the length and diameter of the cylinder. Determine the volume in cm^3.
3. Calculate the density of the metal. Create a table in your lab notebook, which you will use to record your data.

II. Holding the string, lower the metal into the water until it is completely submerged. Record the new water level.

III. Determine the volume of the metal and recalculate the density using this volume and the mass from part I.

IV. Measurement of mineral sample densities using Archimedes principle.

1. Two mineral samples will be supplied. One is a light-colored mineral typical of the material of which the continents are made, and the other is a dark basaltic mineral characteristic of the ocean floors. Carefully determine the mass of each with the pan balance. This mass determination should be made while the rocks are dry- they will pick up a significant mass of water when wet.
2. Tie a light string on each sample so that they can be suspended from the hook above the pan of the balance. Fill a beaker with enough water to submerge the sample and use Archimedes principle to determine the density of each mineral.

V. Determination of liquid density by mass and volume measurement.

1. Determine the mass of your graduated cylinder while dry and then fill about half full with the unknown liquid supplied.
2. Measure the liquid volume and determine the liquid density.

VI. Determination of liquid density using Archimedes principle.

1. Suspend the cylindrical metal sample in the liquid as in part III and measure its apparent mass when submerged.
2. Use Archimedes principle to determine the liquid density.

VI. Record all the data.

3. Results

The results is to be presented graphically or in tabular form, and compare.

4. Discussion

Make a discussion on the experiment and the results obtained.

5. Conclusion

Make a brief conclusion.

References

[1] Fox and McDonald, Introduction to Fluid Mechanics, Wiley, 2011.
[2] https://www.britannica.com/science/
[3] https://en.wikipedia.org/wiki/
[4] http://hyperphysics.phy-astr.gsu.edu/

Title: **An Experiment on Room Ventilation in Preventing COVID-19 Spread**

1. Introduction

Ventilation is the intentional introduction of fresh air into a space while the stale air is removed. It is done to maintain the quality of air in that space. Ventilation is obviously an important factor in mitigating the risk of virus transmission. As a result, optimising ventilation operation should form an integral part of a wider Covid-19 mitigation strategy for all multi-occupancy spaces. This should include investigation into the current ventilation performance in all parts of a building, and implementation of a strategy which is adapted to ensure that ventilation is adequate throughout. For example, multi-occupant spaces that are reused regularly and are poorly ventilated (i.e. those that have a ventilation rate of below 5 l/s/person or a CO_2 level of above 1500 ppm) should be identified and prioritised for improvement. Measuring for elevated CO_2 levels in indoor air is an effective method of identifying poor ventilation performance in multi-occupancy spaces. However, it should be noted that in low occupancy or large air volume spaces, a low level of CO_2 cannot necessarily be used as an indicator that ventilation is sufficient to mitigate risk of transmission.

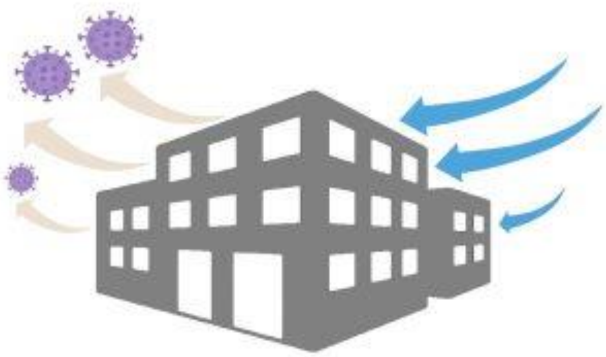


Fig. 1 Ventilation of Buildings

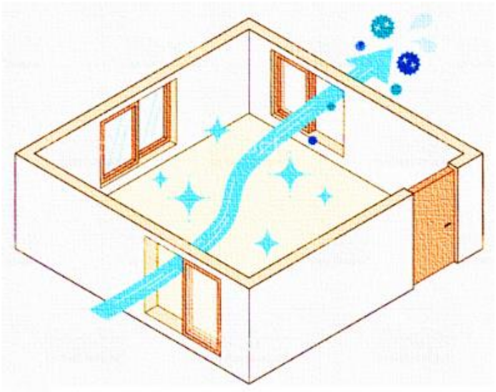


Fig. 2 Room ventilation

Coronavirus is spread through the air by droplets and smaller particles (known as aerosols) that are exhaled from the nose and mouth of an infected person as they breathe, speak or cough. They behave in a similar way to smoke but are invisible. The majority of virus transmissions happen indoors. Being indoors, with no fresh air, the particles can remain suspended in the air for hours and build up over time.

When a room does not have any fresh air, and where people are generating large amounts of aerosol through activities such as singing and loud speech, that is when transmission of coronavirus is most likely. Fresh air must come from outdoors – recirculating air just means the aerosols containing the virus move around the same room rather than being extracted outdoors. Ventilation units or any household systems that use outdoor air can be just as effective as opening windows or doors as long as they are limiting the recirculation of the same air.

Research shows that being in a room with fresh air can reduce your risk of infection from particles by over 70%, as fresh air dilutes the particles. As we spend more time indoors, experts are recommending that people either:

- open windows for short, sharp bursts of 10 to 15 minutes regularly throughout the day
- leave windows open a small amount continuously

This is to remove any infected particles lingering in the room. Additionally, it is advised that any household systems that use outdoor air, including kitchen or bathroom extractor fans, are used correctly and regularly as an additional method to remove infected particles.

As the winter approaches, and inevitably spend more time indoors, fresh air is extremely beneficial. For COVID-19, it is important to ventilate indoor spaces if someone in our home has the virus as this can help prevent transmission to other household members. Finally, we should also let fresh air into our home or working space when you have any visitors and just after they leave in case they are infected. Remember, opening windows alongside washing your hands, covering your face and making space is also essential in reducing our risk of COVID-19.

1.1 Objective

Preventing the spread of COVID-19, a proper and effective room ventilation pattern, an extremely important factor, is to be investigated. Therefore, the main objectives of this experiment are as follows:

- to make a model room
- to visualize the flow in the room during ventilation, and finally,
- to investigate the effective ventilation pattern

2. Experiment

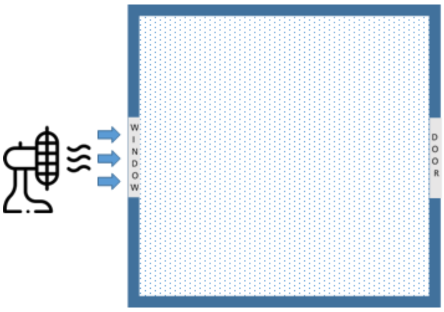
2.1 Experimental Setup & Materils

The following materials are required to conduct the experiment.

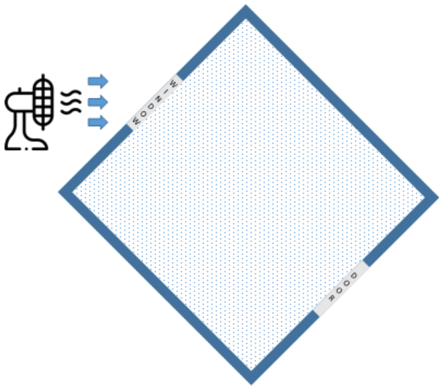
- 5 mm thick paper craft board (white)
- Utility Knife (anti-cutter)
- Paper craft bond or glue
- Transperent Acrylic sheet (3 – 5 mm thick)
- Acrylic sheet cutter
- Sawdust / shradder paper
- Circulator fan(s)
- Video camera (or, smartPhone) for flow visualization

2.2 Procedure

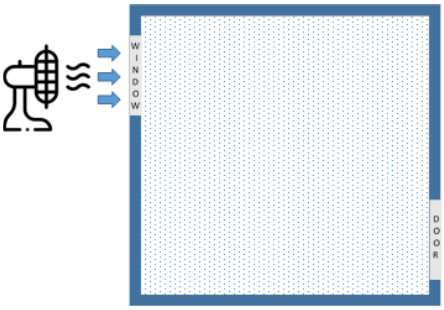
1. Using paper craft board, make a model of a room 15 cm x 15 cm x 7 cm. Open 4cm wide window and door on the room walls. Add a transparent acrylic sheet to the ceiling.
2. Spread and place the sawdust on the floor in the model room.
3. Drive wind by a circulator fan through the window, and obseve and visualize the movement of the sawdust inside the room.
4. Change the window position, number of windows, and air flow direction, and repeat the process mentioned in step 3.
5. Clean the experimental space and collect the sawdust, and make sure the sawdust does not scatter.



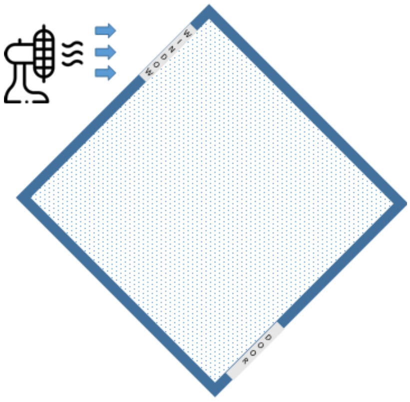
Pattern I



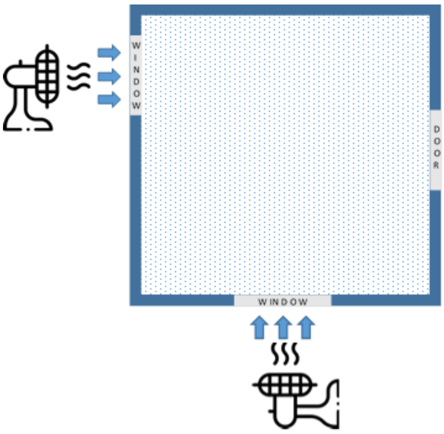
Pattern II



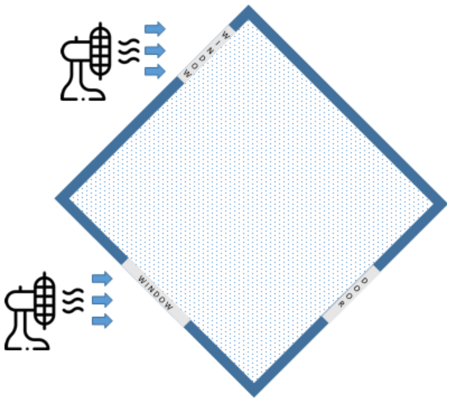
Pattern III



Pattern IV



Pattern V



Pattern VI

N.B.: *Door can be kept open and close in each pattern.*

Fig. 3 Room ventilation patterns

3. Results

The results can be presented pictorially, graphically or in tabular form, and invstigate the effective room ventilation pattern in order to reduce the risk of COVID-19 spread.

4. Discussion

Make a discussion on the experiment and results obtained.

5. Conclusion

Make a brief conclusion.

References

[1] https://energy-ts.com/the-importance-of-ventilation-in-controlling-covid/
[2] https://www.gov.uk/government/news
[3] https://www.puravent.co.uk/
[4] https://www.istockphoto.com/jp/
[5] https://www3.nhk.or.jp/
[6] SAGE EMG paper, Role of Ventilation in Controlling SARS-CoV-2 Transmission
[7] https://www.who.int/

Determination of (a) pipe friction or, co-efficient of friction “*f*” for a pipe and (b) static pressure using a manometer

OBJECTIVES

The main objective of this experiment is to investigate the head loss due to friction in a pipe under different flow regimes. Moreover, the principle of static pressure measurement using manometer is to be learned. On completion, the participants will be able to

1) Estimate the head loss due to friction in pipe flow
2) Determine the friction factors using the Moody diagram
3) Understand the principle of static pressure measurement

THEORY

Pipe flow: When a gas or a liquid flows through a pipe, the flow of fluid through a pipe is resisted by viscous shear stresses within the fluid and the turbulence that occurs along the internal pipe wall. This friction converts some of the fluid’s hydraulic energy to thermal energy. This thermal energy cannot be converted back to hydraulic energy, so the fluid experiences a drop in pressure. In other words, due to this there will be a loss of pressure in the fluid, because energy is required to overcome the viscous or frictional forces exerted by the walls of the pipe on the moving fluid. In addition to the energy lost due to frictional forces, there will be a loss in energy when the fluid flows through fittings, such as valves, elbows, contractions and expansions. This loss in pressure is mainly due to the local flow separation as it moves through such fittings. The pressure loss in pipe flows is commonly referred to as ***head loss***. The frictional losses are mainly caused in a straight pipe, friction loss induced in fittings, such as bends, couplings, valves, or transitions in hose or pipe accounts for minor losses. The frictional losses are referred to as ***major losses*** ***(h_f)*** while losses through fittings, etc, are called ***minor losses*** ***(h_m)***. Together they make up the ***total head losses (h)*** for pipe flows.

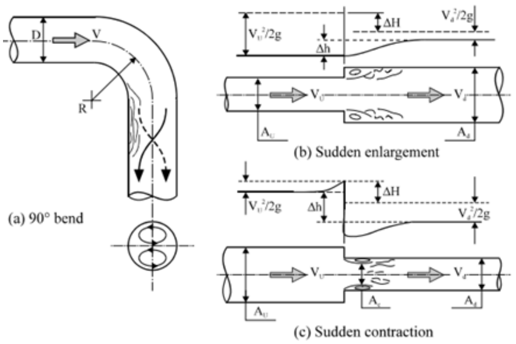


Fig. 1 Types of pipe fittings

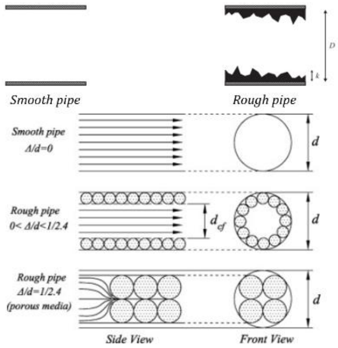


Fig. 2 Internal surface of smooth and rough pipes
(Source: Haung et al 2013)

In practice, loss in a pipe flow comes into picture in cases like calculation of rate of flow in the pipes connecting two reservoirs at different levels or to calculate the additional head required to double the rate of flow along an existing pipeline. These pipe losses are dependent on number of factors like viscosity of the fluid, the size of the internal pipe diameter, the internal roughness of the inner surface of the pipe, the change in elevation between the ends of the pipe, material of the pipe and the length of the pipe along which the fluid travels.

Pipes with smooth surface does not account for larger friction loss, whereas pipes with less smooth walls such as concrete, cast iron and steel fluid requires large energy to overcome the friction induced in a pipe due to the viscosity of liquid. Rougher the inner wall of the pipe, more will be the pressure loss due to friction.

Friction loss in pipe: The friction loss in a uniform, straight sections of pipe, known as "major loss", is caused by the effects of viscosity, the movement of fluid molecules against each other or against the (possibly rough) wall of the pipe. Here, it is greatly affected by whether the flow is laminar or turbulent.

Laminar Flow: It occurs when the fluid flows in parallel layers without adjacent mixing between the layers. In this type of flow there are neither eddies nor cross currents, with fast flow over the center part of the pipe and no movement near the pipe surface. The roughness of the pipe surface influences neither the fluid flow nor the friction loss. For laminar flow Reynolds’s number (R_e) < 2100.

Turbulent Flow: It occurs when the liquid is moving fast with mixing between layers. The speed of the fluid at a point continuously undergoes changes in both magnitude and direction. For turbulent flow Reynolds's number $2100 < R_e < 4000$.

Transitional flow: is a mixture of laminar and turbulent flow, with turbulence flow in the center of the pipe and laminar flow near the edges of the pipe. Each of these flows behaves in different manners in terms of their frictional energy loss while flowing and have different equations that predict their behavior. For transitional flow Reynolds's number $R_e > 4000$.

It is useful to characterize that roughness as the ratio of the roughness height *k* to the pipe diameter D, the "relative roughness". Three sub-domains pertain to turbulent flow:

- In the smooth pipe domain, friction loss is relatively insensitive to roughness.
- In the rough pipe domain, friction loss is dominated by the relative roughness and is insensitive to Reynolds number.
- In the transition domain, friction loss is sensitive to both.

The Darcy Equation is a theoretical equation that predicts the frictional energy loss in a pipe based on the velocity of the fluid and the resistance due to friction. It is used almost exclusively to calculate head loss due to friction in turbulent flow.

$$h_{\mathrm{f}} = \frac{32\mu LV}{\rho g D^2} = \left(\frac{64\mu}{\rho VD}\right)\frac{L}{D}\frac{V^2}{2g} = f\frac{L\,V^2}{2Dg} \tag{1}$$

where, h_{f} = the friction head loss [m], f = Darcy friction factor [-], L = the length of the pipe [m], D =the hydraulic diameter of the pipe [m], V = the mean flow velocity [m/s], and g = the acceleration due to gravity [m/s^2]. In the equation, the Darcy-Weishbach friction factor f is given by

$$f = \frac{64\mu}{\rho VD} = \frac{64}{Re} \tag{2}$$

where, *Re* is Reynolds number giving the ratio of inertia force to viscous force in a flow. As stated earlier, if $Re < 2000$, the flow is laminar.

Equation (1) may also be rearranged as

$$h_{\mathrm{f}} = \frac{32\mu LV}{\rho g D^2} = 2\left(\frac{16\mu}{\rho VD}\right)\frac{L}{D}\frac{V^2}{g} = 2f_{\mathrm{f}}\frac{L\,V^2}{Dg} \tag{3}$$

In equation (3), f_{f} is Fanning friction factor given by

$$f_{\mathrm{f}} = \frac{16\mu}{\rho VD} = \frac{16}{Re} = \frac{1}{4}f \tag{4}$$

For both Darcy-Weisbach and Fanning friction factors are either read from Moody diagram (see Appendix) or calculated using various correlations such as Colebrook equation.

In turbulent flow, the friction factor, f depends upon the Reynolds number and on the relative roughness of the pipe, *k/D*, where, k is the roughness parameter and D is the inner diameter of the pipe. When k is very small compared to the pipe diameter D i.e., $k/D > 0$, f depends only on R_e. When *k/D* is a significant value, at low R_e, the flow can be considered as in smooth regime (no effect of roughness). As R_e increases, the flow becomes transitionally rough, called as transition regime in which the friction factor rises above the smooth value and is a function of both k and R_e and R_e increases more and more the flow eventually reaches a fully rough regime in which f is independent of R_e. For design purposes, the frictional characteristics of round pipes, both smooth and rough are summarized by the friction factor chart, which is a log-log of Fanning friction factor vs R_e which is based on Moody's chart.

EXPERIMENT (A): DETERMINATION OF PIPE FRICTION

Setup & Materials: Figure 3 shows the schematic view of the experimental setup, and the following materials are required to conduct the experiment.

1. 2 (two) plastic box
2. A small aquarium pump
3. PVC pipe (16x2M)
4. Rubber hose pipe (clear, 12x16x2M)
5. Silicone sealant with gun

6. Safety 3 Elbow for Main Hose (12mm) – 2 Nos.
7. Silicone Tube, 4mm x 6mm, 2M
8. Joint Two-Way Hose Fitting (4 mm) – 2 Nos.
9. Clear Rigid Acrylic Pipe 4mm
10. Soldering Iron
11. Steel ruler and stopwatch
12. Sealing Tape

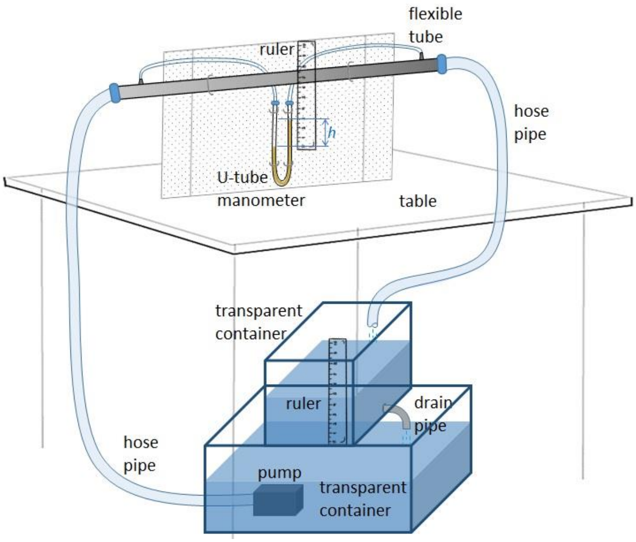


Fig. 3 Schematics of the experimental setup

Procedure: The experiment can be conducted following the procedure given below.

1. Build the experimental setup as shown in figure.
2. Fill the lower box with water and turn on the pump so that water flows along the pipe and also recirculates within the system.
3. Measure the height h in the U-tube manometer.
4. Use the measuring cup to capture a known volume of water over a measured time and calculate the volume flow rate.
5. Calculate the average velocity in the pipe ($U=Q/A$) and Reynolds number ($Re=UD/\nu$).
6. Calculate the head loss h_{fP} along each section of pipe based on the manometer reading for head loss.
7. Calculate the friction factor for the pipe ($f=h_{fp}D^2g/U^2L$) (based on the Darcy-Weisbach equation)
8. Find Darcy-Weisbach friction factor and Fanning friction factor from Moody diagrams and estimate the corresponding head loss.

Data collection:

Given data

Length of the pipe, L = [m],
Diameter of the pipe, D = [m],
Room temperature, T = [K],
Specific weight of the flowing fluid, γ = [N/m^3],
Specific weight of manometric fluid, γ_m= [N/m^3],
Density of the flowing fluid, ρ= [kg/m^3],
Viscosity of the flowing fluid, μ= [Pa.S]

Experimental data

Table 1. Data for determination of head loss

No. of Obs.	Mass of water collected (kg)	Time for collection (s)	Mass flow rate (kg/s)	Manometer reading			Measured head loss (m of H_2O)
				Left column (mm)	Right column (mm)	Net deflection (m)	
1							
2							
3							
4							
5							
.							
.							

Table 2. Data for estimating head loss using Moody diagrams

No. of Obs.	Vol. flow rate (m3/s)	Mean velocity (m/s)	Reynold number, *Re*	Friction factor from Moody diagram		Estimated head loss (m of H_2O)	Hydraulic gradient
				Darcy	Fanning		
1							
2							
3							
4							
5							
.							
.							

Results:

1) Plot experimentally determined head loss against estimated head loss.
2) Plot hydraulic gradient (hf/L) versus velocity in a log-log graph

Discussion:

Make a discussion on the experiment and the results obtained, such as, why does the determined results differ from the estimate results?

Conclusion:

Make a brief conclusion.

EXPERIMENT (B): MEASUREMENT OF STATIC PRESSURE USING A MANOMETER

Setup & Materials: Figure 4 shows the schematic view of the experimental setup, and the same materials that used in **Experiment (A)** can be used to conduct this experiment.

Hydrostatic pressure at a point inside a fluid body at rest is $p = \gamma h$, where h is the depth from the free surface. In U-tube manometer as shown in the figure, the difference in head between points 1 and 2 is given by, $h_f = h(\gamma_m / \gamma - 1)$. Here '*h*' is manometric deflection, different from the '*h*' above.

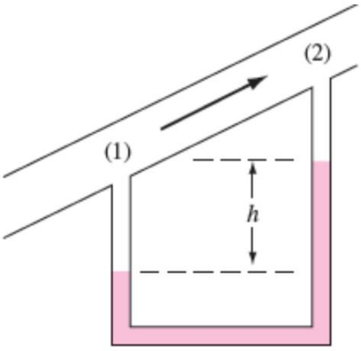


Figure 4 Schematic of U-manometer fixed with pipe

Results:

Table 3. Data for determination of static pressure

No. of Obs.	Manometer reading			Measured pressure (m of H_2O)
	Left column (mm)	Right column (mm)	Net deflection (m)	
1				
2				
3				
4				
5				

Discussion: Make a discussion on the experiment and the results obtained, such as,

(i) What would be the manometer reading if Mercury was used?
(ii) What if fluid with 0.8 sp. gravity was used?

Conclusion: Make a brief conclusion.

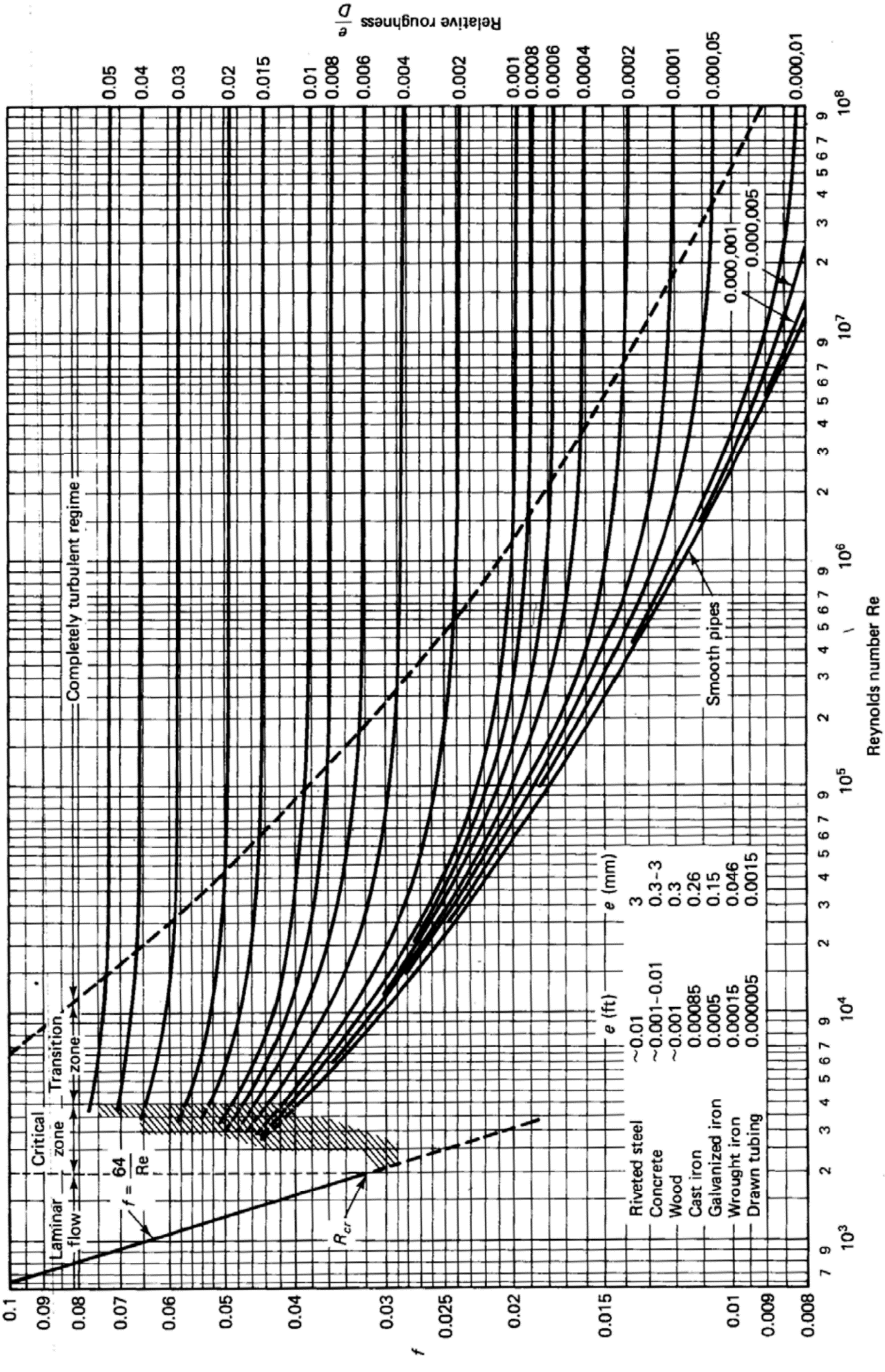
REFERENCES

[1] Miller, R. W., *Flow Measurement Engineering Handbook*, Second Edition, McGraw-Hill, 1989.
[2] Fox and McDonald, *Introduction to Fluid Mechanics*, Wiley, 2011.
[3] Huang et. al., Experimental investigation on friction factor in pipes with large roughness, Exp. Therm. Fluid Sci. 50:147-153, 2013.

APPENDIX

Moody diagram

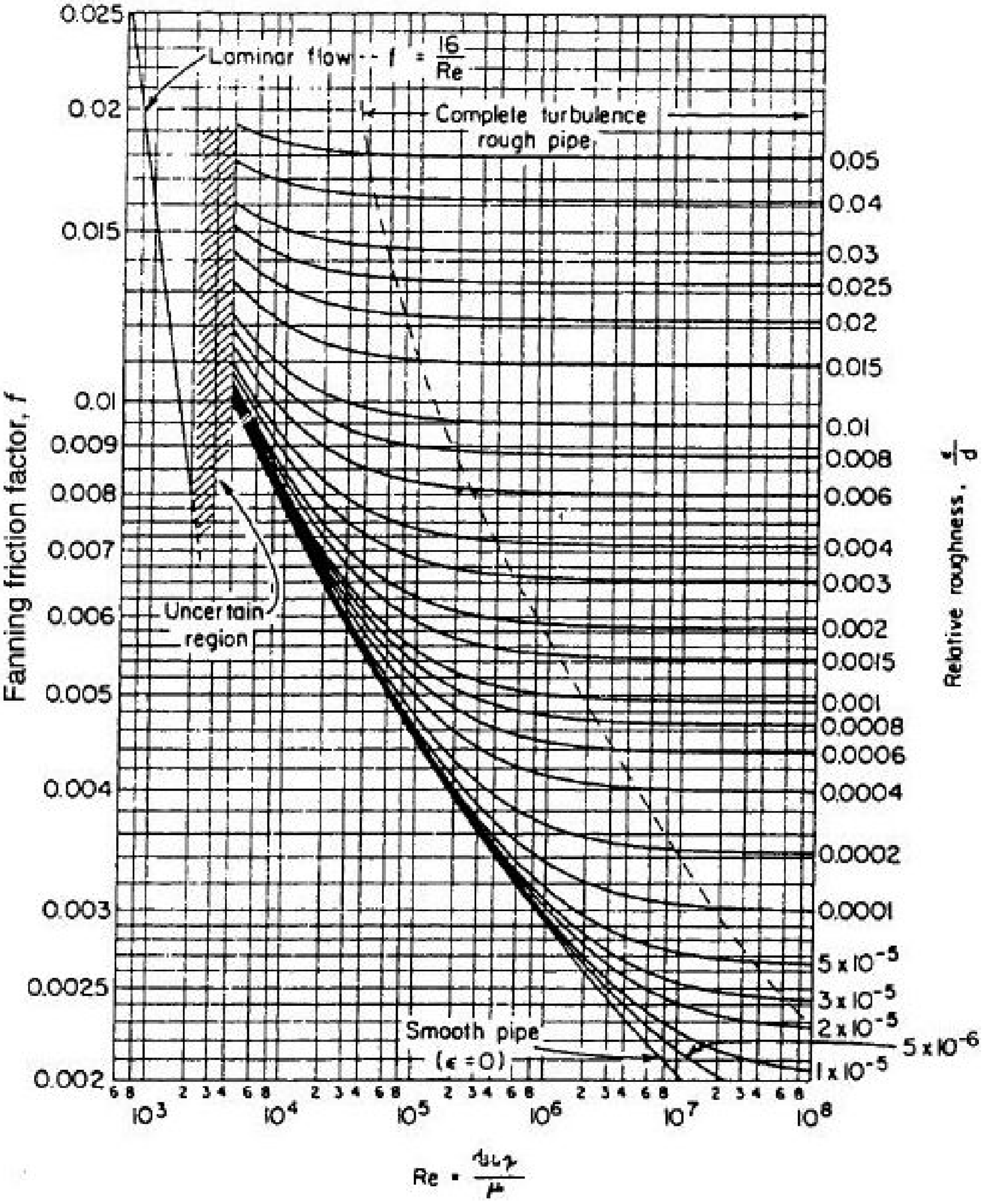
(From L.F. Moody, *Trans. ASME*, Vol. 66, 1944)



	e (ft)	*e* (mm)
Riveted steel	~0.01	3
Concrete	~0.001-0.01	0.3-3
Wood	~0.001	0.3
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Drawn tubing	0.000005	0.0015

Diagram for Fanning Friction Factor

(From Wikipedia)



Tips for teaching programming

1. Introduction

There are some teaching points when teaching programming to beginners, such as the model subject "programming essentials". Learning programming has a different set of challenges and techniques than learning physics or learning to read and write. This paper presents some samples that should be the foundation of any teaching of programming

Objective

Understand the following items:

- How to create easy-to-understand teaching materials
- Peer Instructions
- Live Coding
- How to create an expandable and fun program

2. Theory

2.1 Visual Programming [1]

Visual programming and work decomposition are effective teaching materials as an introduction to beginners who want to learn programming (Python). Don't just code, it is effective to first learn the basics of programming (sequential processing, conditional branching, repetition).

About sequential processing

As a teaching material, I prepared an analog game of programming, such as using commands to operate a character to lead to a treasure chest.

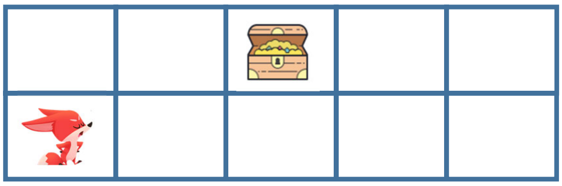
Command introduction

The character can be moved according to the contents of each command.

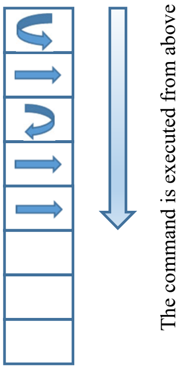
Command (Symbol)	Command Contents
→	Move one square in the direction you are facing
↻	Rotate 90 degrees clockwise
↺	Rotate 90 degrees counterclockwise

Challenge 1

If you can reach the treasure chest by using the command of the character in the figure below, you can complete the task. There are many correct answers. For an example of the correct answer, see "Program example" on the right side of the figure below.



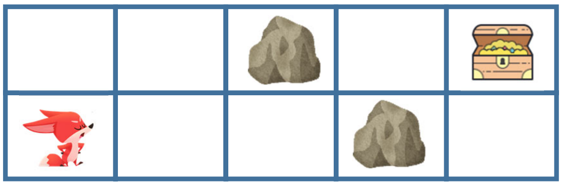
Program example



Challenge 2

Add "rock" as a new rule. Characters cannot pass through rocky squares. The conditions for completing the task are the same as for challenge 1, but participants must create a program that avoids rocks. We will increase the difficulty level of the task in a balanced manner by adding rules.

Can you do this?



Sequential processing, Repetition, Conditional Branch

By performing work decomposition, you will learn the basics of programming:

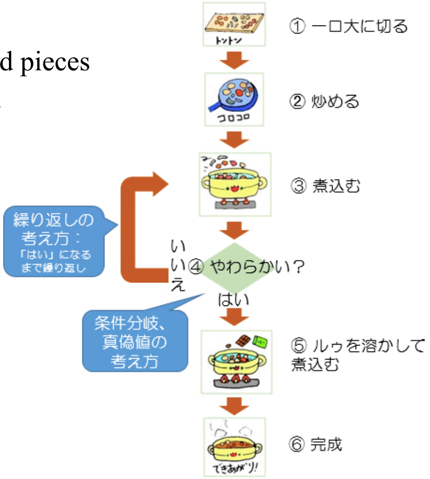
- ✧ sequential processing (also called sequence)
- ✧ repetition (also called loop)
- ✧ conditional branching.

Any work can be reproduced by making full use of these three.

Learn the process of curry making by disassembling the work

First of all, we will give an example of the process of making curry and learn to "disassemble the work".

Here is a work breakdown of the curry making process.



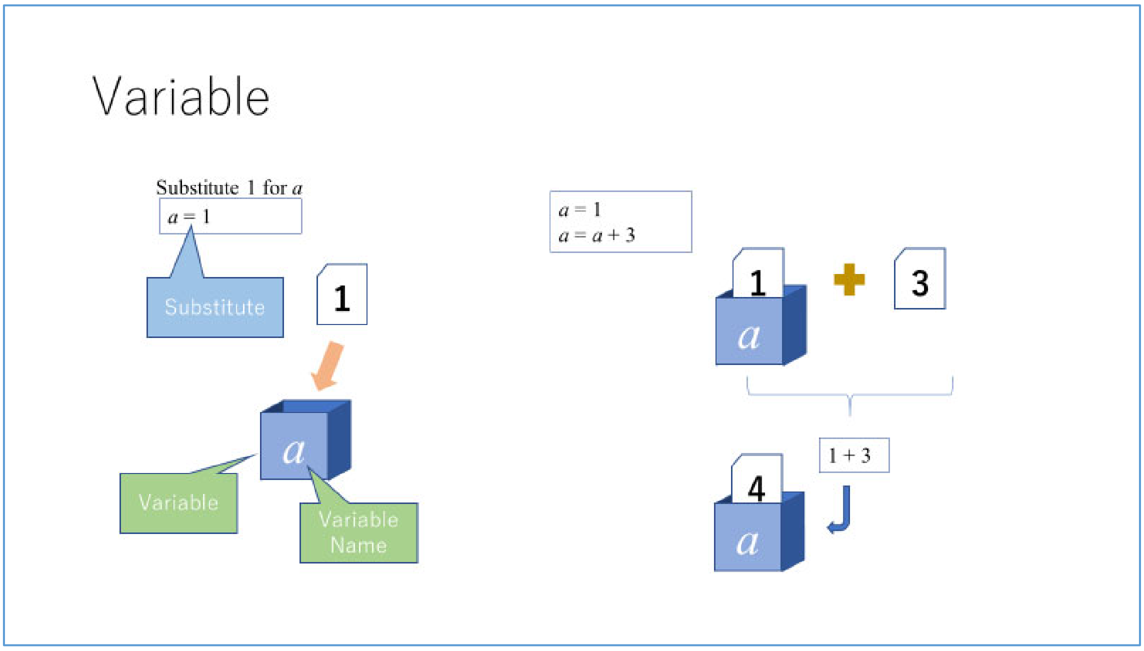
1. Peel vegetables and cut vegetables and meat into bite-sized pieces
2. Stir vegetables and meat in oil, put in a pan and add water
3. Simmer

   Did the vegetables become softer?
4. Go to 5 if yes, go to 3 if no
5. Melting Ru and simmering
6. Curry completed (* not work but for clarity)

2.2 How to create easy-to-understand teaching materials

2.2.1 Visual Teaching Materials

For beginners who are not good at thinking logically, understanding will be promoted by making sensory and visual teaching materials.

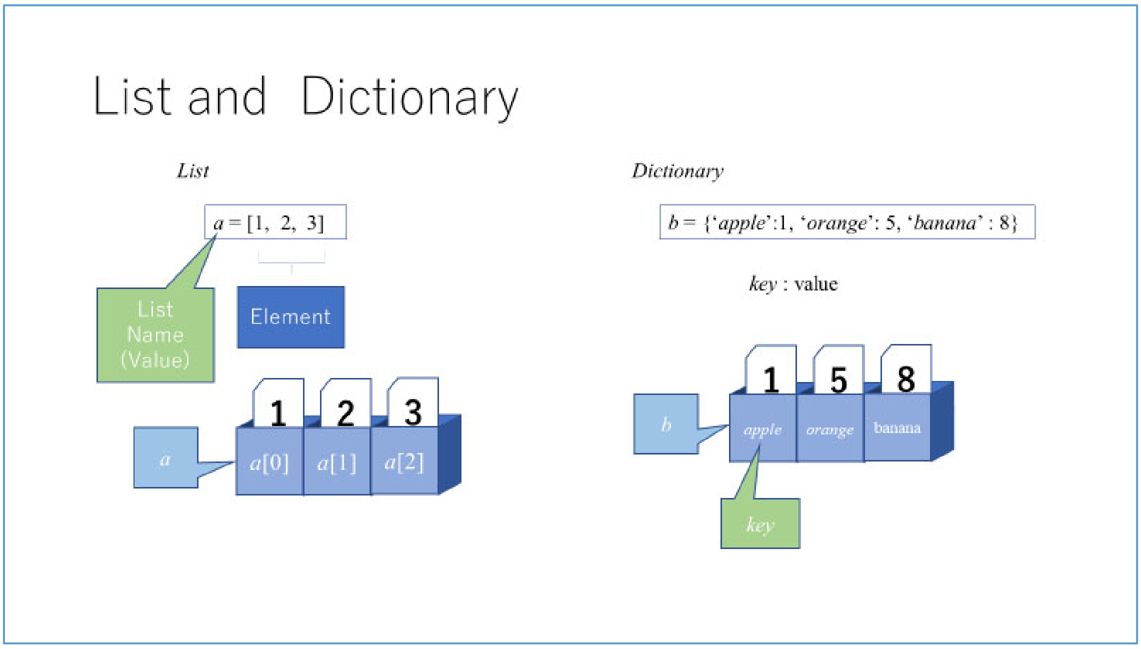


Variable

Substitute 1 for a

$a = 1$

$a = 1$
$a = a + 3$



List and Dictionary

2.2.2 Creating teaching materials using JupyterNotebook

The Jupyter Notebook is a powerful tool for interactively developing and presenting data science projects. A notebook integrates code and its output into a single document that combines visualizations, narrative text, mathematical equations, and other rich media.

I will introduce how to make teaching materials using the interactive features of JupyterNotebook.

Characteristic of JupyterNotebook

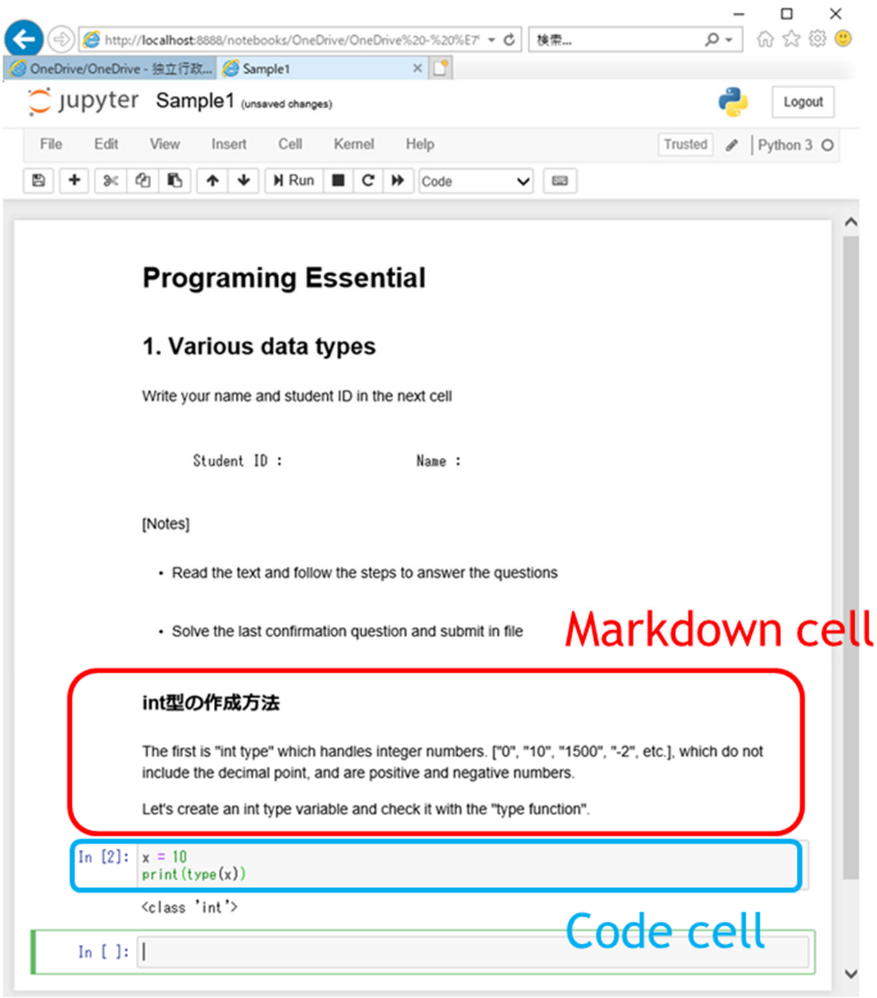
- Perform calculations from the browser
- Supports multiple language processing systems such as Python, R, Julia, Scala.
- Visualization of results
- Describe the description in markup language
- Insert graphs, images, videos, etc. , inline on web pages
- It is possible to record calculation results in a format that is easy to understand intuitively.
- The created content (Notebook) can be published in various formats and shared with third parties.

Composition of teaching materials using Jupyter Notebook

We compose the teaching materials as follows:

1. Description (Markdown cell)
    - Describe the contents of the exercise and its prerequisite knowledge in a markdown cell.
    - Use mathematical formulas and diagrams to help students understand.

2. Example (written code cell)
   - As an example, prepare a cell containing the described code.
   - Students can run the code on the fly and see the results.
   - An application that intentionally prepares an error-producing code and allows students to consider the cause is also conceivable.
3. Fill-in-the-blank problem (partially described code cell)
   - Write only a part of the code, and the student completes the blank part to complete the program.
   - Create code by dividing it into multiple steps (cells).
4. Free answer (blank code cell)
   - Prepare blank cells so that you can freely write the code.
   - It is effective to use it to confirm that you have understood the explanations so far.
   - Use a blank code cell for the assignment to be set for each unit.



Programing Essential

1. Various data types

Write your name and student ID in the next cell

```
Student ID :                Name :
```

[Notes]

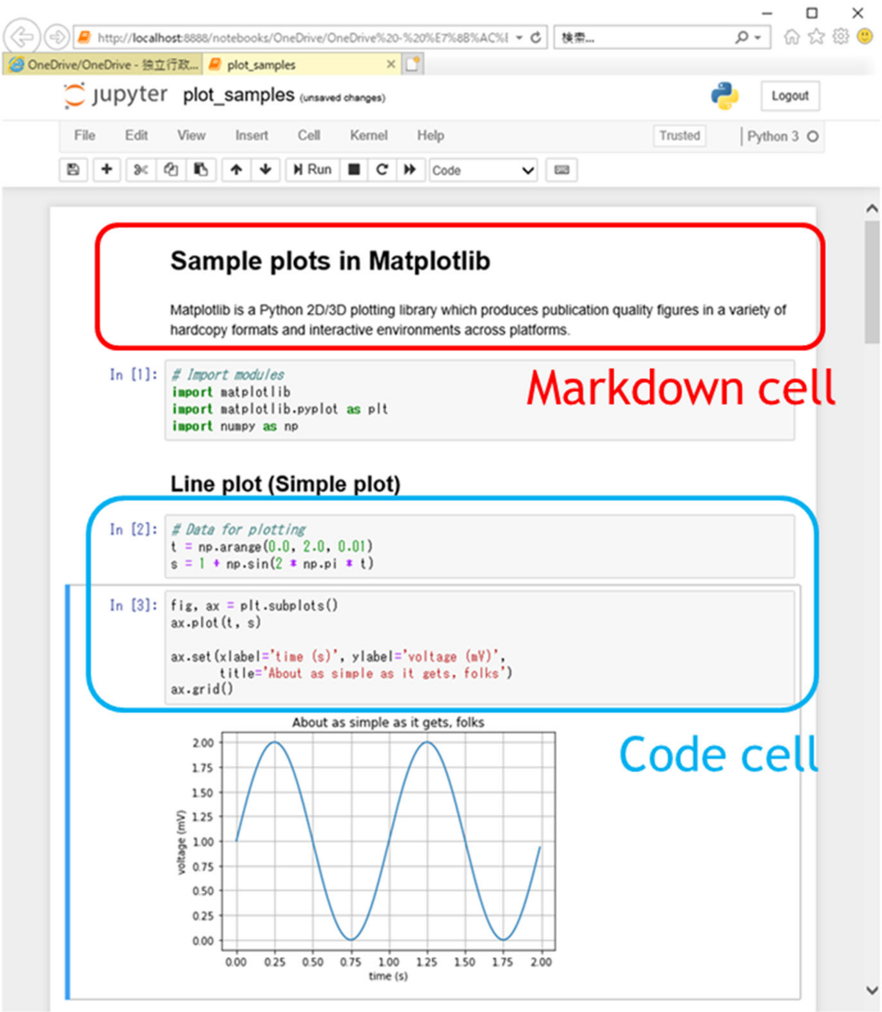
- Read the text and follow the steps to answer the questions
- Solve the last confirmation question and submit in file

int型の作成方法

The first is "int type" which handles integer numbers. ["0", "10", "1500", "-2", etc.], which do not include the decimal point, and are positive and negative numbers.

Let's create an int type variable and check it with the "type function".

```
In [2]: x = 10
        print(type(x))

        <class 'int'>

In [ ]:
```



Sample plots in Matplotlib

Matplotlib is a Python 2D/3D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms.

In [1]:
```
# Import modules
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
```

Line plot (Simple plot)

In [2]:
```
# Data for plotting
t = np.arange(0.0, 2.0, 0.01)
s = 1 + np.sin(2 * np.pi * t)
```

In [3]:
```
fig, ax = plt.subplots()
ax.plot(t, s)

ax.set(xlabel='time (s)', ylabel='voltage (mV)',
       title='About as simple as it gets, folks')
ax.grid()
```

2.3 Peer Instruction [2]

One-on-one tutoring is perhaps the ideal form of teaching: all of a teacher's attention can be focused on one student, and they can completely customize their teaching for that person and tailor individual feedback and corrections based on a two-way dialogue with them. In realistic settings, however, one teacher must usually teach several, tens, or even hundreds of students at once. How can teachers possibly hope to clear up many learners' different misconceptions in these larger settings in a reasonable time? Here, I will introduce a method called peer instruction.

In simplified form, peer instruction proceeds in several phases:

1. The instructor gives learners a brief introduction to the topic.

2. The instructor then gives learners a multiple choice question that probes for misconceptions rather than simple factual recall. (A programming example is given in Code 1 that relates to

integer comparison and loops.) The multiple choice question must be well designed. There is no point asking a trivial question that all students will get right or one with meaningless wrong answers that no student will pick. The ideal questions are those for which 40%±60% of students are likely to get the right answer the first time and those in which every wrong answer corresponds to a misconception that will cause it to be picked by at least some students.

3. Learners then vote on the answer to the question individually, thus formalising their initial prediction.

4. Next, learners are given several minutes to discuss those answers with one another in small groups (typically 2±4 students), and they then reconvene and vote again.

5. Then, the instructor can act on the latest answers. If all the learners have the right answer, the instructor can move on. If some of the wrong answers remain popular after group discussion, the instructor can address those specific misconceptions directly or engage in class-wide discussion.

Peer instruction is essentially a way to provide one-to-one mentorship in a scalable way. Group discussion significantly improves learners' understanding because it forces them to clarify their thinking, which can be enough to call out gaps in reasoning. Repolling the class then lets the instructor know if they can move on or if further explanation is necessary. While it significantly outperforms lecture-based instruction in most situations, it can be problematic if ability levels differ widely. Pair programming can be used to mitigate this.

Code 1: An example multiple choice question probing learners' understanding of loops and integer comparisons

```
for number in range(1,10):
    if number < 3 or number >= 8:
        print("Yes")
```

How many times will the above code print out the word `Yes'?

a) 10

b) 5

c) 4

d) 3

2.4 Pair Programming [2]

Pair programming is a software development practice in which 2 programmers share 1 computer. One person (called the driver) does the typing, while the other (called the navigator) offers comments and suggestions. The two switch roles several times per hour. Pair programming is a good practice in real-life programming and also a good way to teach. Partners can not only help each other out during practical exercises but can also clarify each other's misconceptions when the solution is presented.

Both parties involved in pair programming learn while doing it. The weaker gets individual instruction from the stronger, while the stronger learns by explaining and by being forced to reconsider things that they may not have thought about in a while. When pair programming is used, it is important to put everyone in pairs, not just the learners who may be struggling, so that no one feels singled out. It's also important to have people switch roles within each pair 3 or 4 times per hour so that the stronger personality in each pair does not dominate the session.

2.5 Live Coding [2]

Rather than using slides, instructors should create programs in front of their learners.

This is more effective for multiple reasons:

1. It enables instructors to be more responsive to "what if?" questions. While a slide deck is like a highway, live coding allows instructors to go off-road and follow their learners' interests or answer unanticipated questions.
2. It facilitates unintended knowledge transfer: students learn more than the instructor consciously intends to teach by watching how instructors do things. The extra knowledge may be high level (e.g., whether a program is written top-down or bottom-up) or fairly low level (e.g., learning useful editor shortcuts).
3. It slows the instructor down: if the instructor has to type in the program as they go along, they can only go twice as fast as their learners, rather than 10-fold faster as they could with slides-which risks leaving everyone behind.
4. Learners get to see how instructors diagnose and correct mistakes. Novices are going to spend most of their time doing this, but it's left out of most textbooks.
5. Watching instructors make mistakes shows learners that it's alright to make mistakes of their own. Most people model the behavior of their teachers: if the instructor isn't embarrassed about making and talking about mistakes, learners will be more comfortable doing so too.

Live coding does have some drawbacks, but with practice, these can be avoided or worked around:

1. Instructors can go too slowly, either because they are not good typists or by spending too much

time looking at notes to try to remember what they meant to type.

2. Instructors can spend too much time typing in boilerplate code that is needed by the lesson but not directly relevant to it (such as library import statements). Not only does this slow things down, it can distract learners from the intended thrust of a lesson. If the instructor spends their time typing boilerplate, that may be all that learners take away. This can be avoided by starting with a partial skeleton that includes the boilerplate or having it on hand to copy and paste when needed. (Of the two, we prefer the former, since learners may not be able to keep up with copying and pasting.)

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

Boilerplate code

Note that live coding does not always have to start with a blank screen: instructors may give students some starter code that relies solely on concepts they have already mastered and then extend it or modify it with live coding. Instructors who use live coding should ensure that learners have reference material available after lectures, such as a textbook, but should also recognize that students of all ages increasingly turn to question and answer sites such as Stack Overflow for information.

When instructors are using live coding, they usually run the program several times during its development to show what it does. The key to making demonstrations more effective is to make learners predict the outcome of the demonstration before performing it.

3. Exercises

3.1 Disassemble the "laundry" work

Please discuss with each group to disassemble the "laundry" work.

By thinking with multiple people, you can find out something by listening to the thoughts of other members, or you can solve it even if it is difficult even if you think together.

3.2 Let's make a “Chatbots”

Let's make the program fun to understand the functions of the program such as variables, lists, dictionaries, repetitions, if statement, functions and module(library).

What is a bot?

A bot is a software application that is programmed to do certain tasks.

Chatbots: Bots that simulate human conversation by responding to certain phrases with programmed responses

Chatbot with simple response

First, create a base program for Chatbot.

It is a program that returns the input as it is from the keyboard.

This is repeated using a while statement.

pybot1.py

```
while True:
    command = input('pybot> ')
    print(command)
```

Chatbot to return a greeting

Check if a string exists

Check if element exists in list using python “in” Operator.

Condition to check if element is in List :

```
elem in LIST
```

It will return True, if element exists in list else return false.

For example, check if ‘hello’ exists in list i.e.

```
# List of string
listOfStrings = ['Hi' , 'hello', 'at', 'this', 'there', 'from']
if 'hello' in listOfStrings :
    print("Yes, 'hello' found in List : " , listOfStrings)
```

Switch greetings with conditional branch

Switch back greeting using ‘in’ operator and ‘if, elif, else’ statement

End the repetition

End of repetition by break statement

The break statement terminates the loop containing it. Control of the program flows to the statement immediately after the body of the loop. If the break statement is inside a nested loop (loop inside another loop), the break statement will terminate the innermost loop.

pybot2.py

```
while True:
    command = input('pybot> ')
    if 'Hello' in command:
        print('Hello')
    elif 'Thank you' in command:
        print('Welcome')
    elif 'Goodbye' in command:
        print('Goodbye')
        break
    else:
        print('Sorry, I can not understand.')
```

Make greetings dictionary data

pybot3.py

```
bot_dict = {
    'Hello': 'Hello',
    'Thank you': 'Welcome',
    'Goodbye': 'Goodbye',
    }                                   # Dictionary

while True:
    command = input('pybot> ')
    response = ''                       # Set empty string as initial value
    for key in bot_dict:              # Execute for loop for the number of dictionary keys
        if key in command:              # Set the value if the conditions are met
            response = bot_dict[key]
            break                       # Exit the loop
    if not response:                    # Processing when empty character
        response = 'Sorry, I can not understand.'

    print(response)

    if 'Goodbye' in command:
        break
```

Let's use datetime module and function

Let's create a function that handles date and time.

In Python, date and time are not a data type of its own, but a module named datetime can be imported to work with the date as well as time.

Please study how to use the module by referring to the sample below.

pybot4.py part1

```
from datetime import datetime, date

bot_dict = {
    'Hello': 'Hello',
    'Thank you': 'Welcome',
    'Goodbye': 'Goodbye',
    }

def today_command():
    today = date.today()
    response = 'Today is {}'.format(today)
    return response

def now_command():
    now = datetime.now()
    response = 'The current date and time is {}'.format(now)
    return response

def birth_command():
    birth, year_str, manth_str, day_str = command.split()
    year = int(year_str)
    manth = int(manth_str)
    day = int(day_str)
    birth_day = date(year, manth, day)
    today = date.today()
    response = 'Days since you were born = {} '.format(today - birth_day)
    return response
```

Creating a more complicated command will lengthen the while loop and make the entire program confusing. In such cases, it is easier to understand by dividing the program into functions.

pybot4.py part2

```
while True:
    command = input('pybot> ')
    response = ''
    for key in bot_dict:
        if key in command:
            response = bot_dict[key]
            break
    if 'Date' in command:
        response = today_command()
    if 'Now' in command:
        response = now_command()
    if 'Birth' in command:
        response = birth_command()

    if not response:
        response = 'Sorry, I can not understand.'
    print(response)

    if 'Goodbye' in command:
        break
```

Execution result of pybot4.py

```
Python 3.7.7 (bundled)
>>> %Run pybot4.py
pybot> Hello
Hello
pybot> Date
Today is 2020-08-23
pybot> Now
The current date and time is 2020-08-23 21:38:07.472960
```

```
pybot> Birth 1955 5 24
Days since you were born = 23833 days, 0:00:00
pybot> Thank you
Welcome
pybot> Goodbye
Goodbye
>>>
```

Challenge 1

Let's create a program that reads greeting data from a file.

File read sample:

```
open_file = open(‘greeting_data.txt’)
raw_data = open_file.read()
open_file.close()
```

Challenge 2

Let's create a program that returns a message when an exception error occurs.

An ValueError occurs because the date is not enough written:

```
pybot> Birth 2020
Traceback (most recent call last):
  File "C:¥Users¥text¥program¥pybot4.py", line 41, in <module>
    response = birth_command()
  File "C:¥Users¥ text¥program¥pybot4.py", line 20, in birth_command
    birth, year_str, manth_str, day_str = command.split()
ValueError: not enough values to unpack (expected 4, got 2)
```

Exception handling is written using **try** statement.

```
try:
  …….
except ValueError:
  …….
```

4. Discussion

Let's exchange information about problems when teaching programming. Also, you can share your tips here with others.

References

1. http://techblog.sega.jp/entry/2020/04/27/100000
2. Neil C. C. Brown1, Greg Wilson, Ten quick tips for teaching programming, PLoS Comput Biol 2028 14(4): e1006023. https://doi.org/10.1371/journal. pcbi.1006023.

Hands-on Manuals for Practical Training and Experiment

March 2022

Electrical Technology

Technology	Electrical
Model Subject	Alternating Current Machines 1
Semester	6th Semester
Subject Code	66761

Determination of Transformation Ratio of a Transformer

Electrical Technology (Blue Team)

Sabera Sultana, Attached Officer(Stipend Cell), DTE
Shamsunnahar Khanam, Instructor, DPI
Md. Mohshinul Karim, Instructor, DPI

March 2022

Title: Determination of Transformation Ratio of a Transformer

1. Objective

1) To obtain transformation ratio of a rated transformer by measuring primary and secondary voltage.
2) To obtain transformation ratio of a rated transformer by measuring primary and secondary turns.

2. Theory

A transformer is a passive component that transfers electrical energy from one electrical circuit to another circuit keeping the frequency constant. A transformer has primary and secondary coils.

a ratio now exists between the number of turns of the primary coil divided by the number of turns of the secondary coil. This ratio, called the ratio of transformation, more commonly known as a transformers “turns ratio”, (TR).

Transformation Ratio: $a = \frac{N_p}{N_s}$ ………..(1)

Transformation Ratio can also be determined by measuring the ratio of primary and secondary voltage.

Transformation Ratio: $a = \frac{V_p}{V_s}$ …………(2)

From these two equations (1) and (2) we get,

$$\text{Transformation Ratio}: \; a = \frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

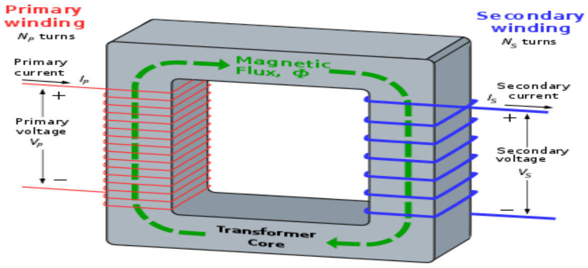


Fig-1: Basic Structure of a Transformer

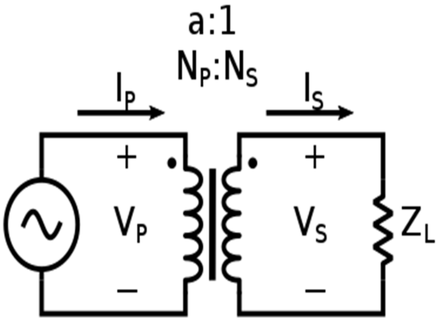


Fig-2: Connection Diagram

3. Experimental Method

3.1Experiment Apparatus

1) Two winding Transformer (Circuit Trainer Board) – one
2) Variable ac Power Supply (Variac)- one
3) Voltmeter - two
4) 0-15 Ampere Ammeter - two
5) Wattmeter -one

3.2. Precaution

1) Meter connection must be according to meter range.
2) Primary and secondary sides of transformer should detect correctly.
3) Connections must be tight and taped.
4) While taking meter reading then meters are taken vertically.
5) Polarity must be determined before connection.
6) Check the circuit connection before power supply.

3.3 Experiment Procedures

1) Connect the circuit as shown in the diagram.
2) Switch on the a.c. supply.
3) Connect a Variac with Primary Coil of the transformer.
4) Record voltage Vp across primary and Vs across secondary.
5) Take different value of Vp by varying the Variac.
6) Measure secondary voltages of different primary voltages of transformer.
7) Measure transformation ratio by taking the ratio of different primary and secondary voltages.
8) Compare the measured transformation ratio with the transformation ratio we get from primary and secondary turns.
9) Switch off a.c. supply.

4. Results

4.1 Figure

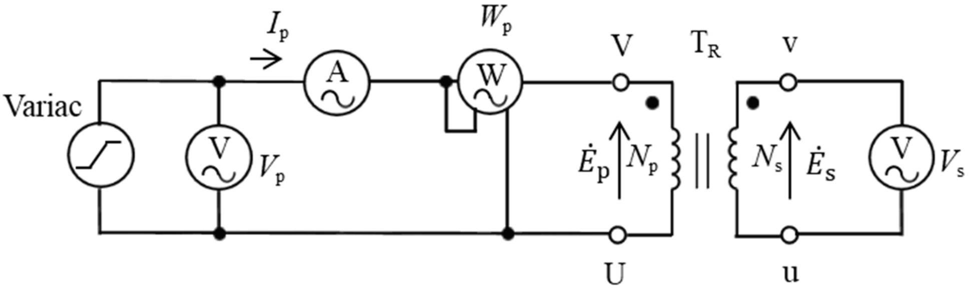


Fig-3: Working Ckt of single phase transformer

4.2 Data Table

$$a = \frac{N_\mathrm{p}}{N_\mathrm{s}} = \frac{V_\mathrm{p}}{V_\mathrm{s}} = \frac{I_\mathrm{s}}{I_\mathrm{p}}$$

*V*p [V]	*I*p [A]	*W*p [W]	*V*s [V]	a=*V*p/*V*s	cos*Φ*=*W*p/(*V*p*I*p)	*Error* [%]	a=*I*s/*I*s

In this experiment we will measure several Secondary voltages with respect to different primary voltages. By using the equation of transformation ratio we obtain different transformation ratios for different set of voltages. Then we compare the ratios with previously calculated transformation ratios which we find from the turns of primary and secondary coils. Transformation ratio found in both step should be equal. If they are not equal then we calculate the Percentage of Error with the equation mentioned in the table.

5. Discussion

- Ideally transformation ratio should be equal in both voltage and turns ratio method. Examine the current ratio with voltage ratio and turns ratio.
- What is the relationship between *I*p and *I*s with the *V*p and *V*s?

6. References

1) Textbook of Electrical Technology: BL Theraja
2) Principles of Electrical Machines - VK Mehta
3) https://en.wikipedia.org/wiki/Transformer

Technology	Electrical
Model Subject	Alternating Current Machines 1
Semester	6th Semester
Subject Code	66761

Perform Transformer Banking (V-V and T-T Connection)

Electrical Technology (Green Team)

Tapas Kumer, Assistant Professor, TTTC
Md. Mahbub Hasan Rabbu, Instructor, DPI
Md. Babul Hosssain Tarun, Junior Instructor, DPI

March 2022

Name of the experiment

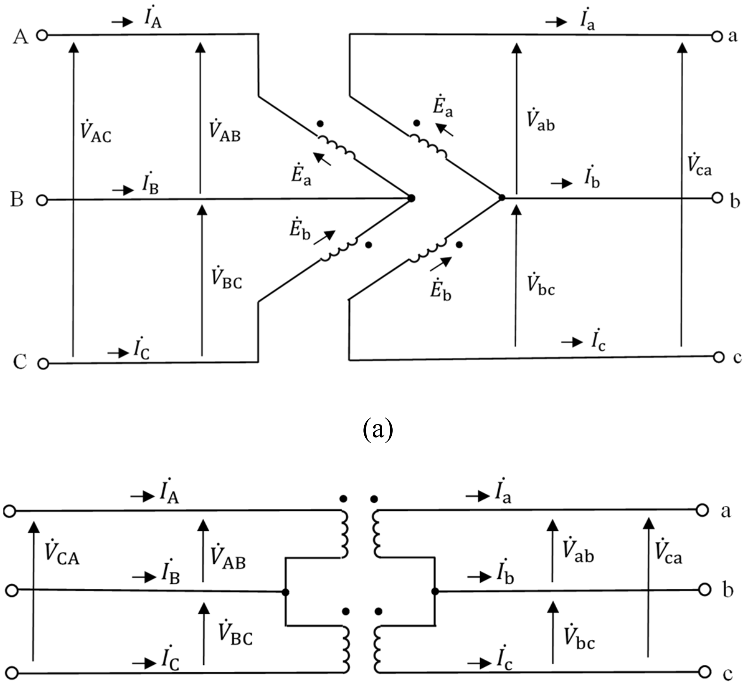
Perform transformer banking (V-V and T-T connection)

1. Objectives

1. To obtain balanced two-phase supply from three-phase supply
2. To perform resistor load test (unity power factor) for both balanced and unbalanced loads and compare the test results with calculations.
3. To obtain single-phase supply from three-phase supply.
4. To observe and calculate quadrature of secondary side voltage of transformers.
5. To acquire the phase angle relationship between the secondary load currents of transformers.

2. Theory:

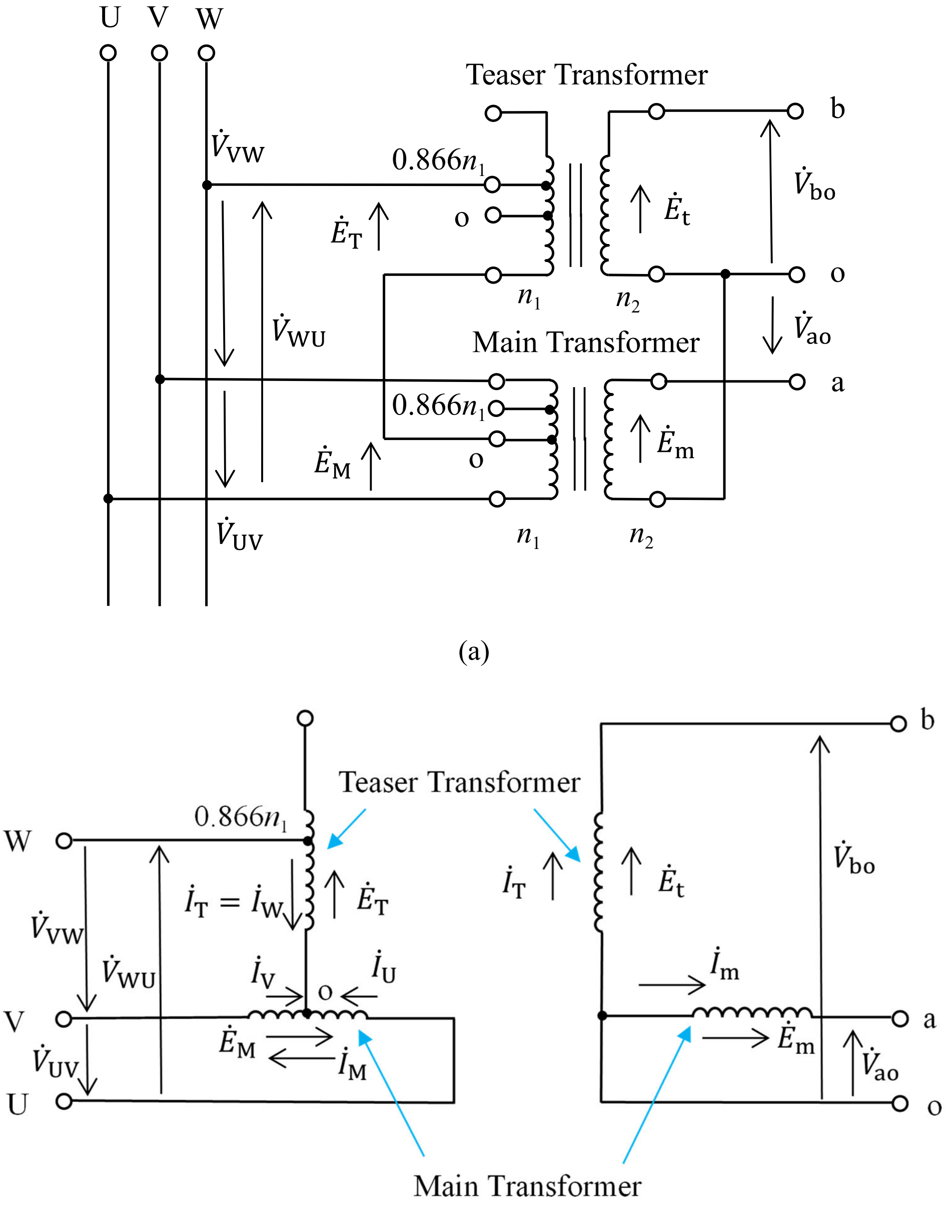
An open delta connection transformer uses two single-phase transformers to provide a three-phase supply to the load. An open delta connection system is also called a V-V system. Open delta



(a)

(b)

Fig.1 V-V Connection of Transformer



(a)

(b)

Fig.2 T-T Connection of Transformer

connection systems are usually only used in emergency conditions, as their efficiency is low when compared to delta-delta (closed delta) systems (which are used during standard operations).

The Scott-T Connection is the method of connecting two single phase transformers to perform the 3-phase to 2-phase conversion and vice-versa. The two transformers are connected electrically but not magnetically. One of the transformers is called the main transformer, and the other is called the auxiliary or teaser transformer.

3. Equipment

1. Transformer 1-phase -220/110V, 50 HZ……………………………. . .. 03
2. Voltmeter (0-300 Ac)……………………………………………………02
3. Voltmeter (0-150 Ac)……………………………………………………02
4. Screw driver (15 cm)…………………………………………………….01
5. Plyers and Knife…………………………………………………………01

Precaution

1. Polarity must be determined before connection.
2. The accuracy of the circuit has to be checked before supply.
3. Loose connection should be avoided.
4. The KVA rating of transformer should be the same.
5. Primary and secondary tapping points should be observed during T-T connection.
6. Must be ware PPE during practical class.

Procedure

1. The correct polarity of the transformer must be determined, and the correct staining or sign must be given.
2. Prepare the circuit according to circuit diagram and the check the point to point connection using multi meter if there is any lose connection.
3. The single phase load on secondary sides of teaser and main transformers should be made connecting the three resistor banks of resistive load cart in series to have more load combinations under rating currents of transformers.
4. Measure the primary and secondary line and phase voltage and write down in the data sheet.
5. Determine the transformation ratio of each method.

4. Results

Data Sheet

V-V Connection of Transformer

SL.No.	V_{AB} [V]	V_{BC} [V]	V_{CA} [V]	V_{ab} [V]	V_{bc} [V]	V_{ca} [V]	V_{ab}/V_{AB}	V_{bc}/V_{BC}	V_{ca}/V_{CAc}	Comments
1										
2										

T-T Connection of Transformer

SL.No.	E_{x1} [V]	E_{y1} [V]	E_{x2} [V]	E_{y2} [V]	Comments
1					
2					

Discussion

1. Compare the Voltages of V-V connected and Δ-Δ connected transformer.
2. Explain voltage ratio, current ratio and transformation ratio.

Technology	Electrical
Model Subject	Alternating Current Machines 1
Semester	6th Semester
Subject Code	66761

Start a 3- Phase Induction Motor by Star-Delta Starter by Using PLC

Electrical Technology (Red Team)

Engr. Shiuly Rani Biswas, Chief instructor and HOD, DPI
Md. Asaduzzaman, Instructor, DPI
Mohammad Solaiman, Junior Instructor, DPI

March 2022

Title: Start a 3- phase induction motor by Star-Delta Starter by using PLC.

1 Objectives:

To learn how to Start a 3 phase induction motor Star-Delta Starter by using PLC.
To develop conception about the function of Magnetic contractors and PLC.
To know how to connect and Operate NC and NO Switch.

2 Theory

[2]Most induction motors are started directly on line, but when very large motors are started in that way, they cause a disturbance of voltage on the supply lines due to large starting current surges. To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage is reconnected when they run up to near rated speed. One of the two methods used for reduction of starting voltage are star delta starting.

2.1 Working Principal of Star-Delta Starter

This is a reduced voltage starting method. Voltage reduction during star-delta starting is achieved by physically reconfiguring the motor windings as illustrated in the figure below. During starting the motor windings are connected in Star configuration and this reduces the voltage across each winding . This also reduces the torque by a factor of three. After a period of time the windings are reconfigured as Delta and the motor runs normally.

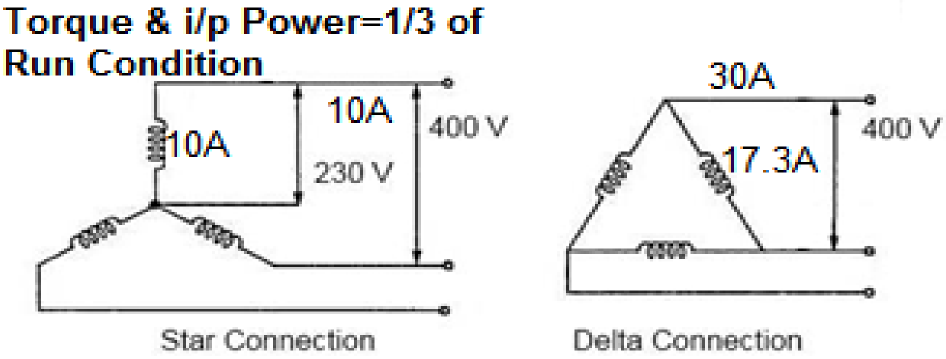


Fig: 1 Star and Delta connection circuit

Star/Delta starters are probably the most common reduced voltage starters. They are used in an attempt to reduce the starting current applied to the motor during start as a means of reducing the disturbances and interference on the electrical supply.

In many supply regions, there is a requirement to fit a reduced voltage starter on all motors greater than 5HP (4KW). The Star/Delta (or Wye/Delta) starter is one of the lowest cost electromechanical reduced voltage starters that can be applied.

The Star/Delta starter is manufactured from three contactors, a timer and a thermal overload. The contactors are smaller than the single contactor used in a Direct on Line starter as they control winding currents only.

There are two contactors that are closed during run, often referred to as the main contractor and the delta contactor. The currents through the winding are 1/root 3 (58%) of the current in the line. These are rated at 58% of the current rating of the motor. The third contactor is the star contactor and that only carries star current while the motor is connected in star. The current in star is one third of the current in delta, so this contactor can be rated at one third (33%) of the motor rating. [2]

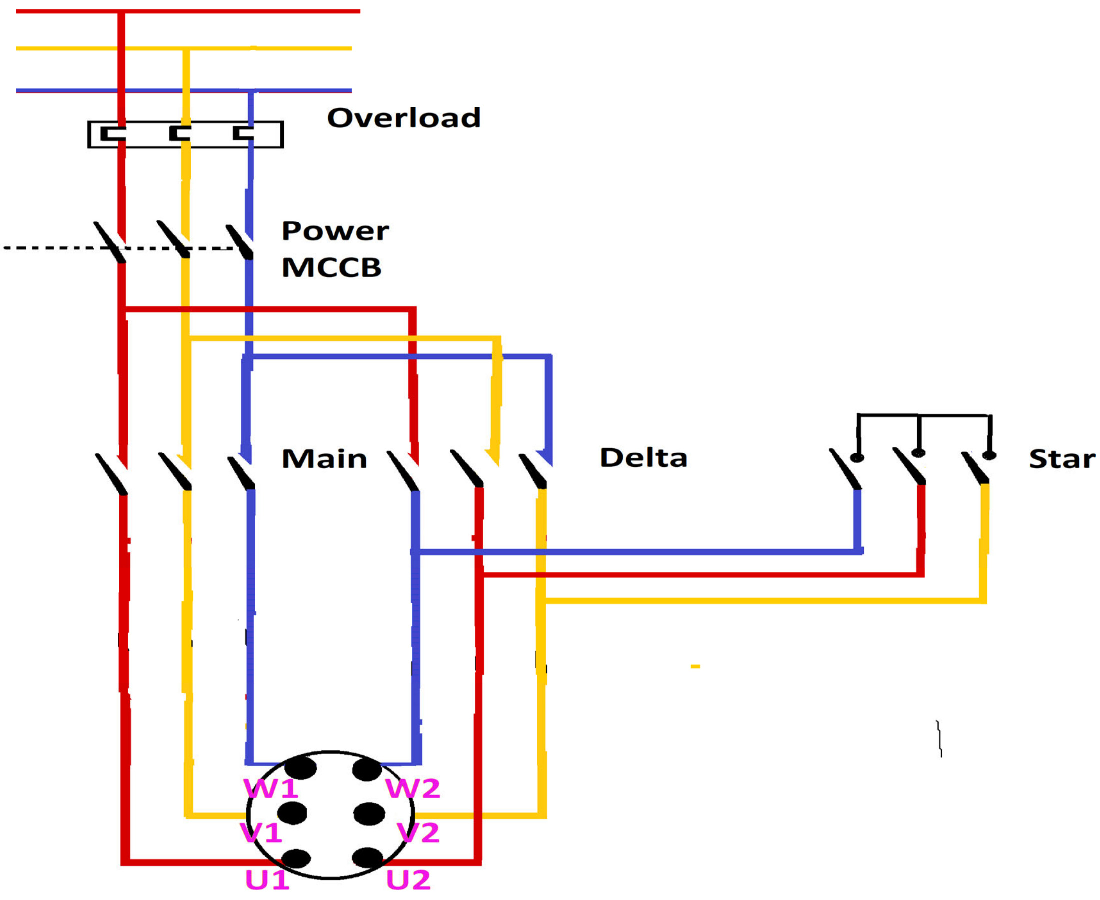


Fig: 2 Power Circuit of Star Delta Starter:

Automatic Star Delta Starter design normally consists of three Magnetic contactors, an overload relay or circuit breaker, NC Switch, NO Switch and a timer for setting the time in the Star connection (starting position)

2.2.1 Self Holding Circuit

[4]We connect relay and push button as per figure. When we press push button, supply goes to relay A1 point and relay gets ON and its contact changes, but when we release push button supply cutoffs and relay gets off. But relay not do not fall in hold. So here we think what we shall do for relay to hold. Now we use NO contact of relay for hold.

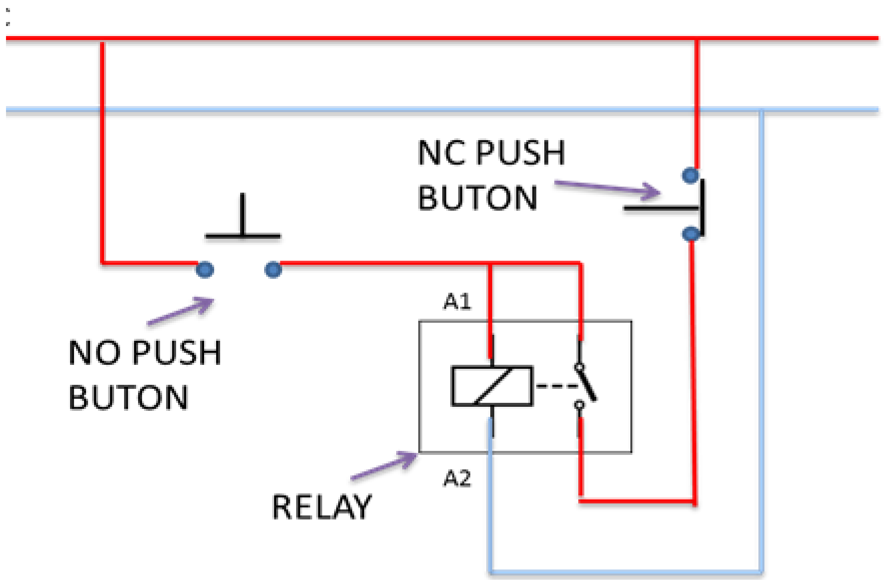


Fig 3 : Holding Circuit using PUSH BUTTON

Now we make line diagram of above example.

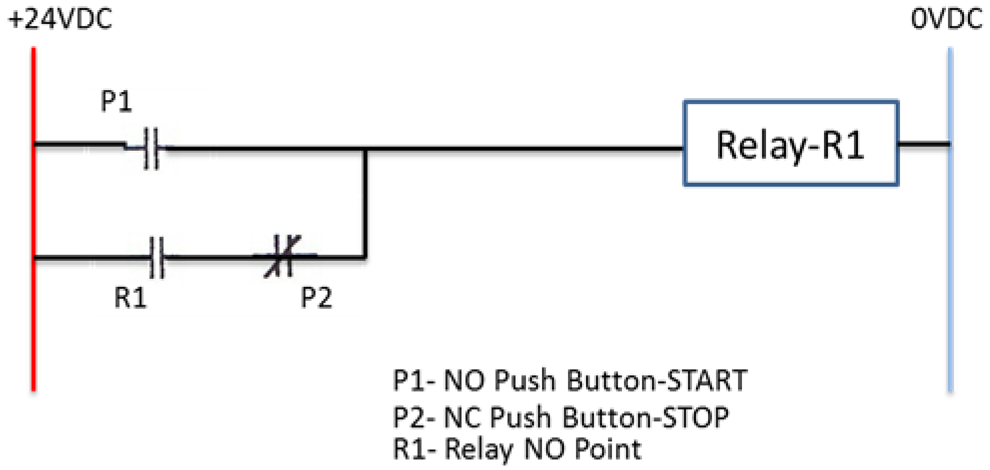


Fig:4 Relay hold line Diagram

2.2.2 Contactor Interlocking Circuit

[3]When an electrical circuit has two contactors and only one of them needs to be turned on at a time then the interlocking system is used. The interlocking system ensures that only one contactor can be on while another one will be in off condition even if we try to manually on. An example of an **Interlocking Circuit is given in Fig (4) below. When S1 push button is pressed C1 start contact is closed. Now If S1 is released, C1 contact still be hold in closed condition. Similar for S2 and C2.**

As per the diagram, the coil of contactor 1 is connected through the NC points of contactor 2 and the coil of contactor 2 is connected through the NC points of contactor 1.

So when contactor 1 is in ON condition, its NC contacts become open so contactor 2 can not be turned on even we push the switch S2 to turned on contactor 2 manually.

When contactor 2 is in ON condition, its NC contacts become open so contactor 1 can not be turned on even we push the switch S1 to turned on contactor 1 manually

An interlocking system is very useful for motor starter and power circuits. In a three-phase star delta motor starter, two contactors are used. One provides star connection while another provides delta connection. During starting time the Star-connected contactor will on and during the running condition delta connected contactor will on. If both of them are turned on at the same time, there will be a short circuit. So the interlocking system in a star-delta starter prevents the short circuit.

The interlocking system in a changeover circuit helps to connect the load with one source of power supply and isolated it from another source of power supply. Interlocking system has applications in motor starter (star-delta), power control circuits, power changeover circuits, etc. [3]

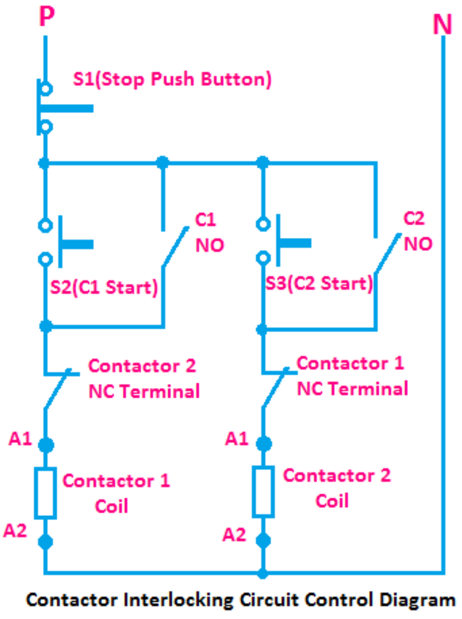
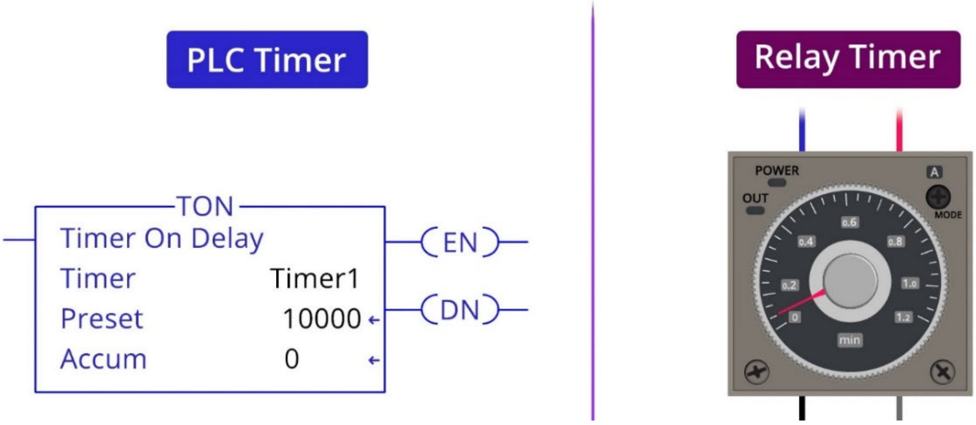
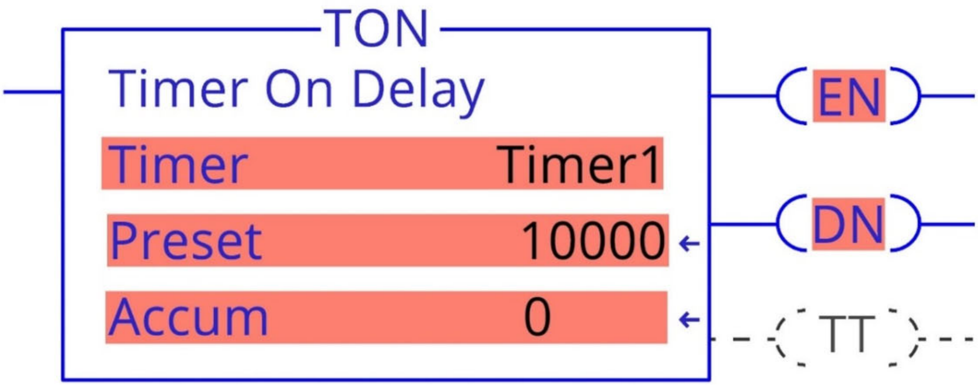


Fig: 4: Interlocking Circuit

2.2.3 PLC Timer

[5] PLC timers are internal PLC instructions that can be used to delay input and output signals in the PLC program.
These timers operate like relay timers but you cannot hold a PLC timer in your hand and they do not need to be connected to wires to operate.



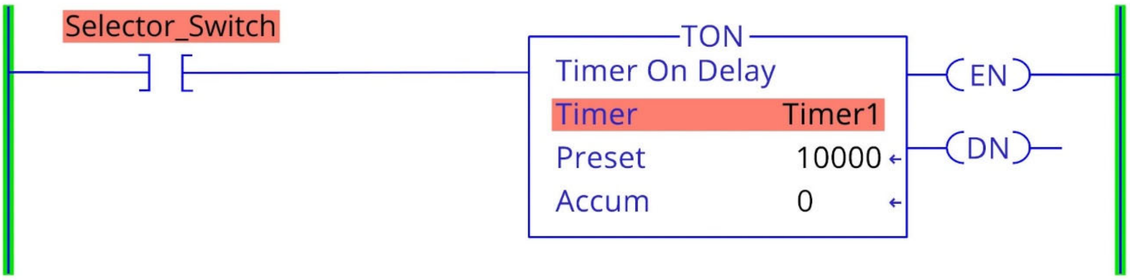


2.2.3 .1 Timer file name

The timer file name is a **PLC tag**. This tag is where you can find the timer's preset and accumulated values and the timer enabled, timing, and done bits.

Some PLCs create the timer file name for you and other PLCs have you create the timer file name.

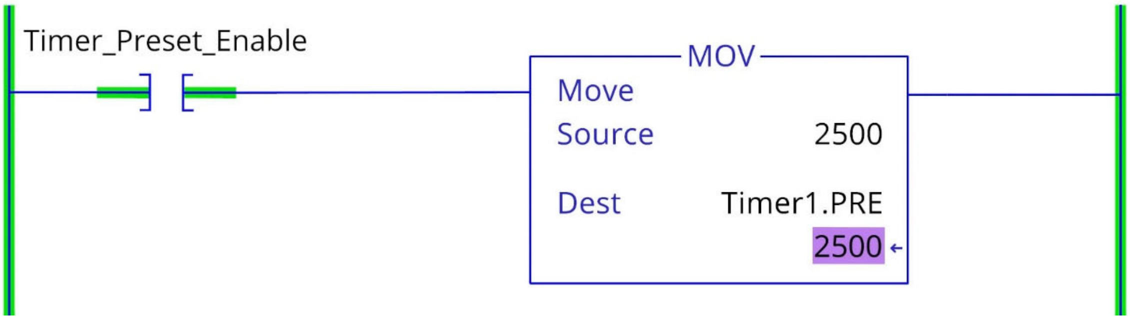
Timer file may use a selector switch to enable and disable the timers1



2.2.3.2 Timer preset value

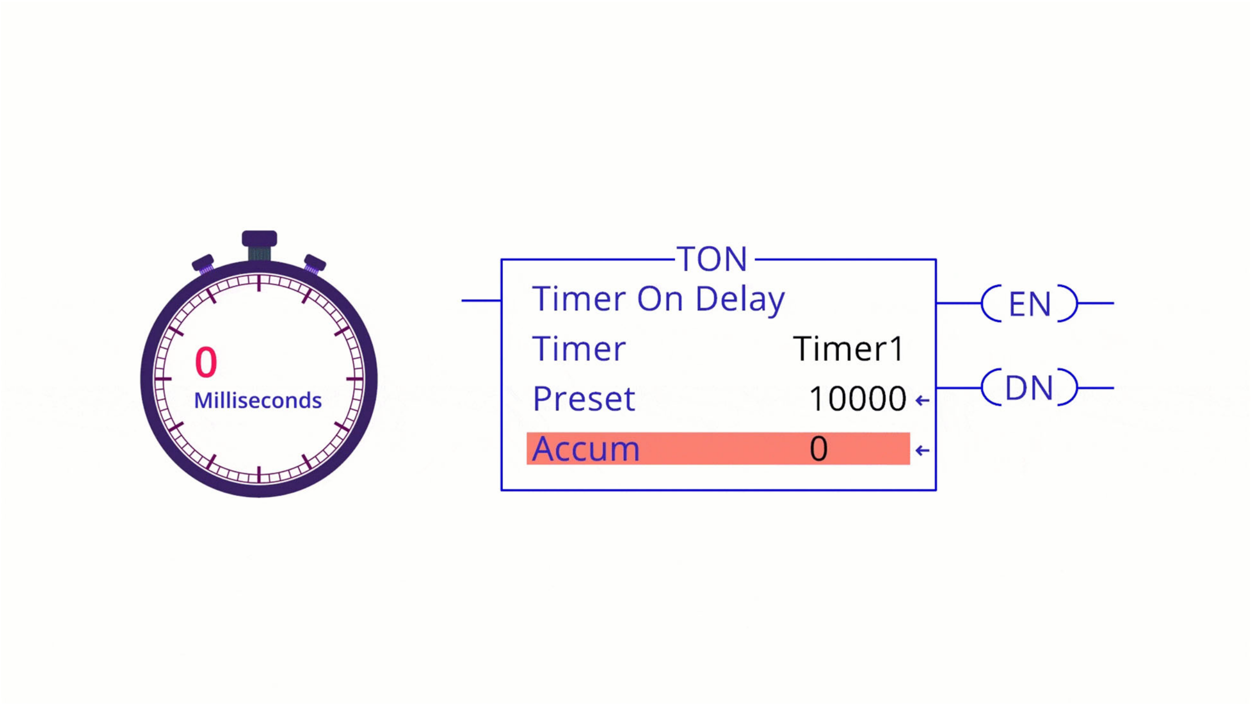
The timer preset value is the number that shows the delay length of the timer.

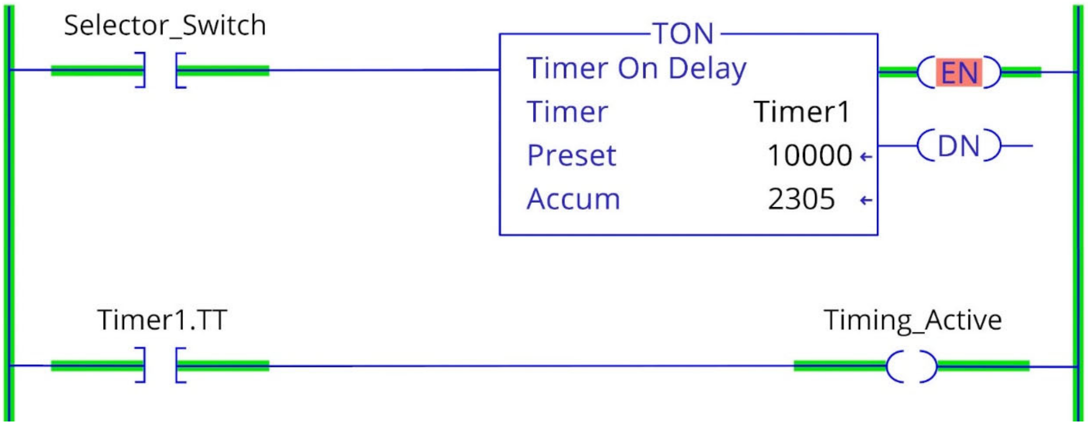
This number can be changed by just typing it in or you can have the PLC write a number into this value. This number does **not** change during the timer's normal operation.



2.2.3.3 Timer accumulated value

The timer accumulated value is the number that shows how long the timer has been timing. The timer accumulated value does not function the same on all of these timers. I will explain how this value accumulates time as I explain how each timer works.

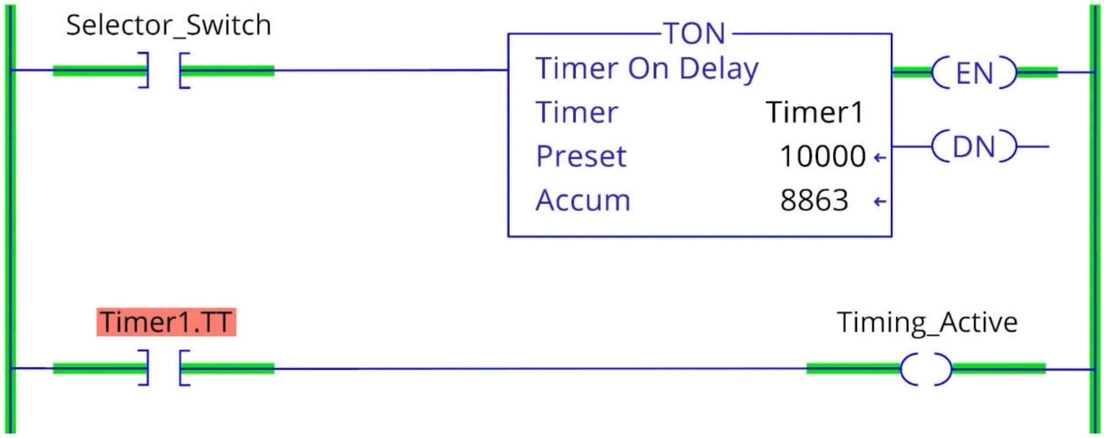




2.2.3.4 Timer timing bit

The timer enabled bit will be on when the timer is enabled

The timer timing bit will be on when the timer is timing1



2.2.3.5 On-delay timer

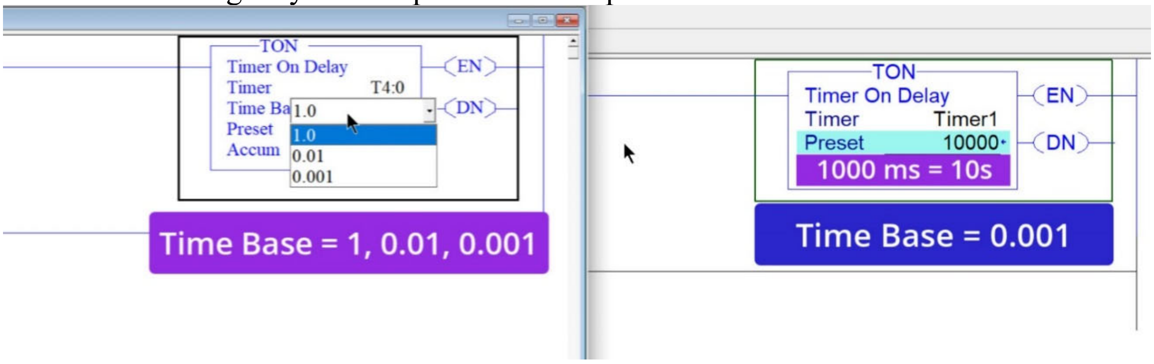
For the first example, I will talk about the on-delay timer.

Let’s start by placing a new on-delay timer instruction on a PLC rung with a selector switch input.

Type the timer file name Timer1.

Next, enter the timer preset so that it equals ten seconds. Notice that I typed ten thousand, I did this because the **time base** of the timer I used is in milliseconds and ten thousand milliseconds equals ten seconds.

Not all PLC timers use the same time base, some have time bases that cannot be changed while others will give you multiple time base options.

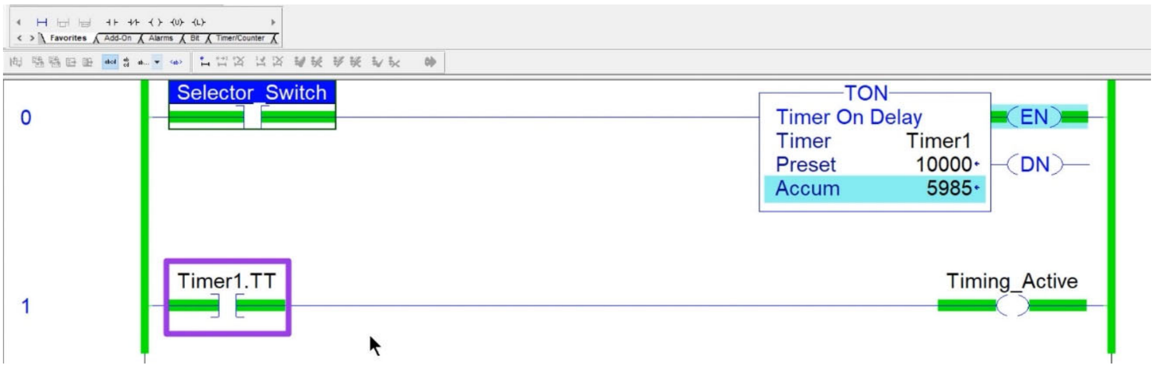


This PLC on-delay timer is now set up and ready to use.

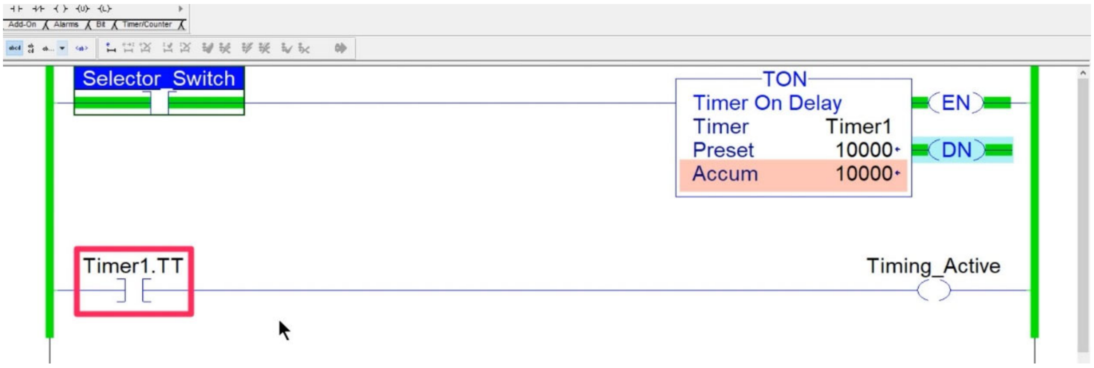
2.2.3.6 How does an on-delay timer work

Next, I will discuss what happens to the PLC on-delay timer when the selector switch gets turned on and off.

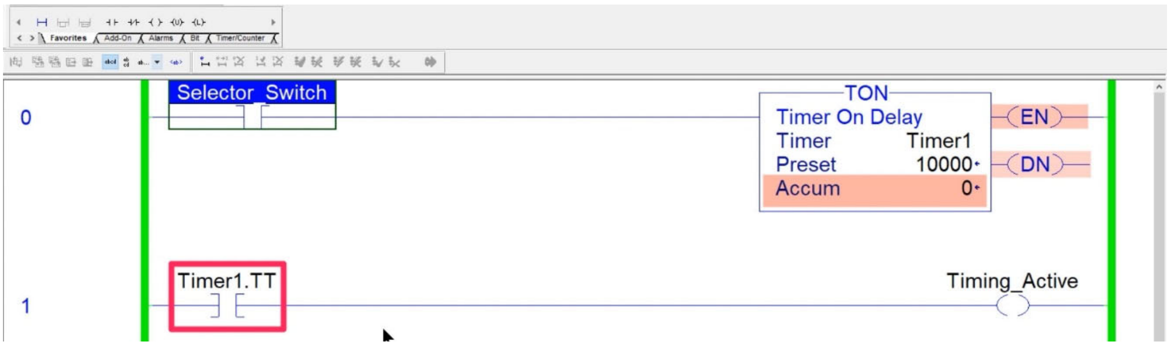
– When you turn on the selector switch, the timer enabled bit and timer timing bit turn on and the timer's accumulated value starts accumulating time.



If you leave the selector switch on, the timer's accumulated value will reach ten thousand. When it does, the timer will stop accumulating time, the timer timing bit will turn off, and the timer done bit will turn on.



At this point, when you turn off the selector switch the timer accumulated value will reset back to zero, and the timer enabled and timer done bits will turn off.



[5]

2.3 Control circuit

[1]A control circuit is for the automatic control of equipment, for safety interlocking, and sequencing the operations of the plant equipment and machines.

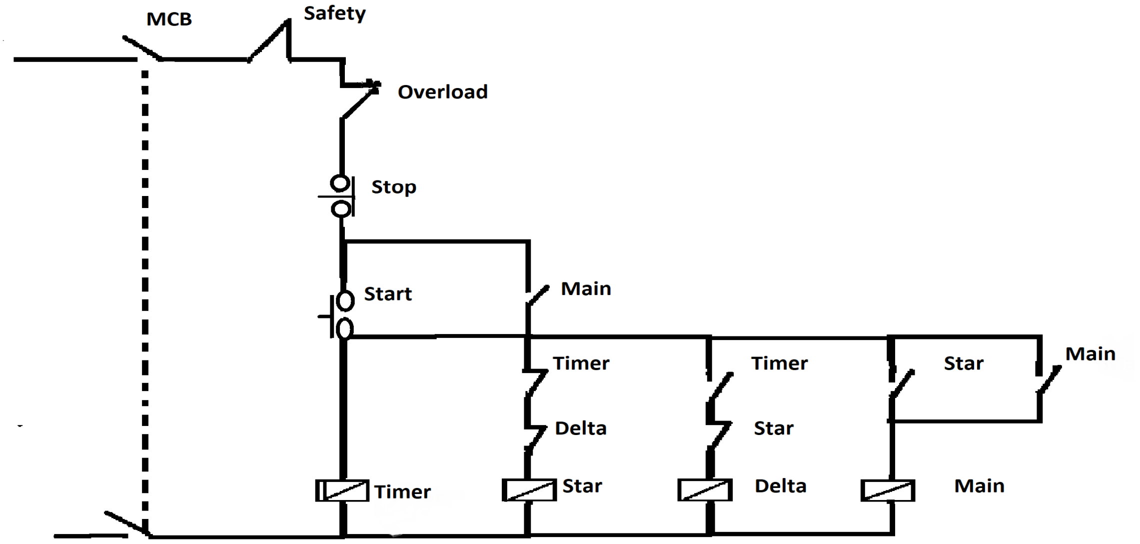


Fig: 5 Control circuit of Star Delta Starter

Control circuits hardware consists of relay contacts, wires, hardware timers and counters, relay coils etc. These consist of input contacts representing various conditions; the output coils are energized or de-energized depending on the input conditions represented by the control circuit. [1]

When ‘Start’ switch is pressed (Fig 5)

a) Relay coil of magnetic contactor for star connection (Star coil) gets energized and motor starts running with Star connection
b) Time delay relay timer is energized simultaneously with the relay coil of Star coil.
c) NO Start contact gets closed. As a result power is supplied to the coil of Main magnetic contactor. NC Star contact which is connected in series with Delta coil gets open so that Delta relay as well as magnetic contactor for delta connection remain separated from supply this time
d) Main coil being energized closes two NO main contacts. One of them is connected in parallel with Start switch another is connected in parallel with Star NO contact.

These two contacts latch main magnetic contactor with the supply when Star switch and Star NO contact be open during Star and Delta connections respectively. Main magnetic contactor be latched with the power supply for both the cases as the motor goes in Star and Delta connections.

e) NC contacts of Delta and Timer relay coil are connected in series with Star relay coil. NC contact of Star relay coil and NO contact of Timer coil are connected in series with Delta relay coil.

[3]Normally closed auxiliary contacts from both STAR and DELTA contactors are placed opposite of both star and delta contactor coils, these **interlock contacts** serves as safety switches to prevent simultaneous activation of both star and delta contactor coils, so that one cannot be activated without the other deactivated first. Thus, the delta contactor coil cannot be active when the star contactor coil is active, and similarly, the star contactor coil cannot also be active while the delta contactor coil is active.[3]

Once the time delay is reached its specified Time, the timer's auxiliary contacts operate. The NC timer contact gets opened i.e changes its position from NC to NO and NO timer contact gets closed i.e changes position from NO to NC . Which results the following actions:

i) Relay coil of Delta Magnetic contactor gets energized and open the NC Delta contact connected in series with the relay coil of magnetic contactor for Star connection (Star coil).
ii) Star coil gets de-energized closing the Star NC contacts connected in series with Delta relay coil
iii) Motor starts running in Delta connection and continues as long as the Stop switch is not pressed.

2.4 Reading and understanding ladder logic

[1]Once the hardwire relay logic concepts are understood then its easy to comprehend ladder logic.

The term 'Programmable Logic Controllers' (PLCs) originated from relay-based control systems. In a PLC, there is full flexibility to change the sequence of operations and interlocks for different conditions.

There are integrated circuits and internal logic in the PLC, in place of discrete relays, coils, timers, counters, and other such devices.

PLCs provide greater computational capabilities and accuracy, to achieve increased flexibility and reliability, than hard-wired relays.

The symbols and control concepts used in PLCs come from relay-based control and form the basis of ladder logic programming (Fig. 6).

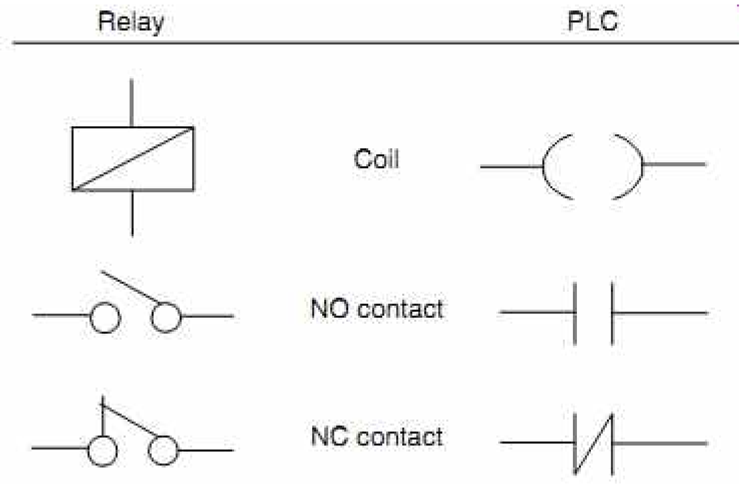


Fig. 6 Comparison of relay and PLC terms

The terminology used in commercially available PLCs from various manufacturers may differ slightly but the concepts remain the same.

2.5 Ladder logic diagram

A ladder logic diagram is so-called because the relay logic runs in parallel lines between two power lines and the whole diagram resembles a ladder.

This diagram consists of one vertical line running down the left side, with the horizontal lines branching off to the right. The line on the left is called the bus bar, while horizontal lines are instruction lines or rungs. Along the instruction lines conditions are placed, that lead to other instructions on the right side. Power flow is always from left to right. Therefore, the logical combination of these conditions from left to right side determines when and how the instructions at the right side are executed. In a ladder logic diagram, instruction lines can have multiple branches. The vertical pairs of lines are called conditions. Conditions without diagonal lines through them are called NO conditions that correspond to AND, LOAD, or OR instruction.

The conditions with diagonal lines through them are called NC conditions that correspond to AND NOT, LOAD NOT, or OR NOT instruction. Each condition has a number above/below each condition that indicates the operand bit for the instruction. Operand bit (Input/ Temporary bit) is associated with that condition.[1]

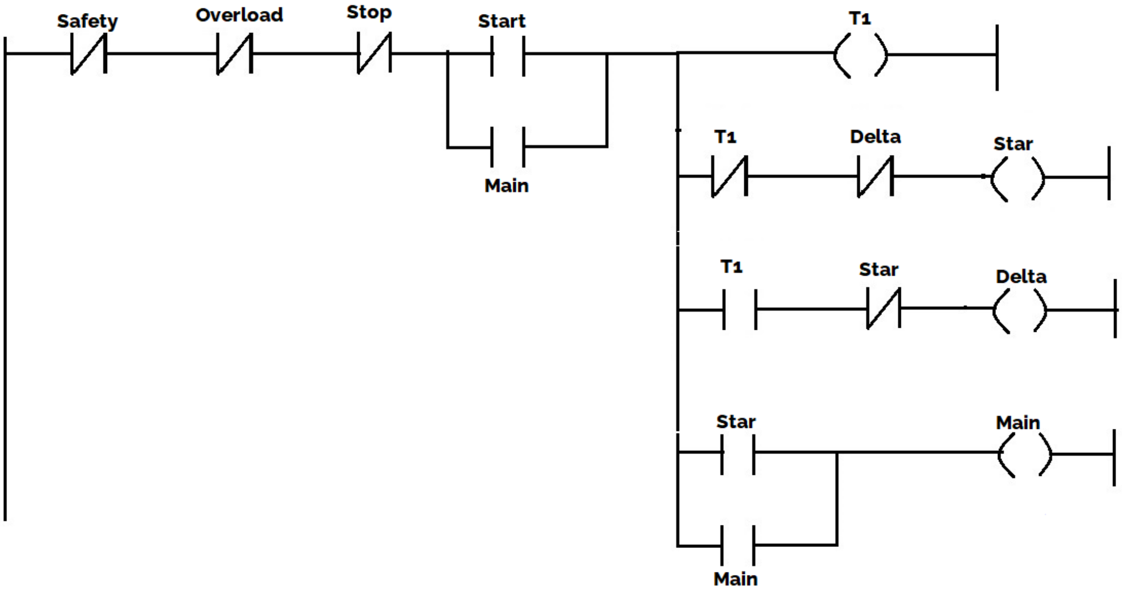


Fig: 7 Ladder Diagram for PLC

Function of the ladder logic diagram (Fig 7) is similar as the function of the control circuit (Fig 5).

2.6 Basic terms used in ladder logic

[1]Normally open and normally closed conditions Each condition in a ladder logic diagram is either 'ON' or 'OFF' depending on the status of the operand bit that has been assigned to it. A NO condition is 'ON' if the operand bit is 'ON' and it is 'OFF' when the operand bit is 'OFF'. On the other hand, a NC condition is 'ON' if the operand bit is 'OFF' and it is 'OFF' when the operand bit is 'ON'. In short, an NO condition simply follows the bit status (on => on and off => off) and an NC condition follows inverted bit status (on => off and off => on).[1]

3.1 Equipment Setup & Materials:

Magnetic contactor,
Over load relay,
MCCB,
PLC (Siemens),
Tester,
Screw driver
Indicating lamp
3-phase motor etc.

3.2 Diagram for PLC

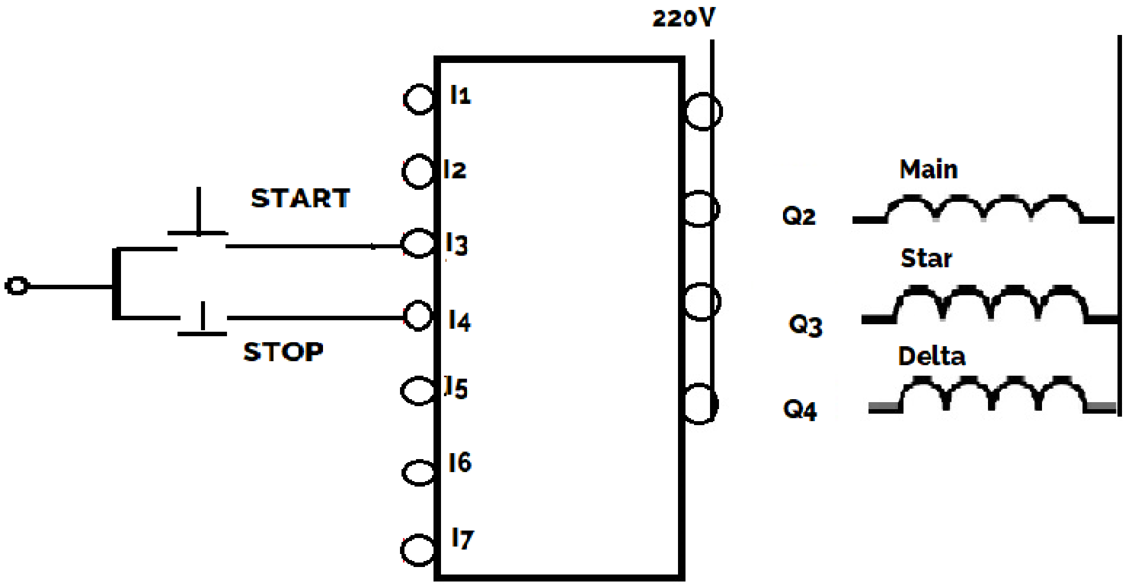


Fig: 8 Connection Diagram using PLC

3.3 Experimental procedure:

Connect over load relay MCCB, and main magnetic contactor in series as shown in circuit diagram. Output of MCCB goes to one side of motor terminals and magnetic contactor for delta connection.

Output of Delta contactor goes to another side of motor terminals and one side of magnetic contactor for star connection.

In another side of magnetic contactor for Star connection, 3 terminals are shorted. [Fig2]

Prepare a ladder diagram for PLC and load it to a PLC device connected to the Star - Delta starter (Fig6]

Before supply check the point to point connection of the whole circuit with the help of a multi meter if there is any loose or open contact.

Supply power and observe the Output.

4. Result

Data Table:

Sl	I (star)	V (star)	Time (Timer)	I (delta)	V (delta)
1					
2					
3					

Observe and Compare the Operation of star-Delta starter by using PLC, the same operation can be done more safely and easily than manual and auto Star-Delta starter.

5. Discussion :

Power is very important for a country. There are many investment producing it. So it needs to be handled in an efficient manner. When the load of a motor is less than 50%of full load it is switched to be operated in Star connection to save energy and the motor itself. When the load is increased above 50% it is automatically switched to operate in Delta connection without disturbing the motor connection. When the motor starts without a Star-Delta starter, starting current would be the 4-6 times of the full load current. An over-sized power capacity cable is required to handle the initial high starting current. This technic reduces starting current and starting torque.

By efficient use if we can save one unit of energy, it can reduce 2 to 2.5 times of capacity creation in this regard.

To change the sequence of operations and interlocking system at different condition use of PLC helps to provide improved accuracy, flexibility and reliability

Now a days most of the industries are going to automated system to face IR4. PLC is being frequently used for the purpose. So it is very important to learn its use in practical classes.

Students need to wear PPE before Starting the Experiment.

Answer to the following Questions:

- What is the time elapsed to change the state from Star to Delta Position.
- How to Operate NC and NO switch ?
- What is the change of current during Star-Delta position?

6. Reference:

［1］ http://www.industrial-electronics.com/ptee_2.html
［2］ https://electricalnotes.wordpress.com/2012/03/16/star-delta-starter/
［3］ https://www.etechnog.com/2021/04/contactor-interlocking-circuit-wiring.html
［4］ https://er.yuvayana.org/how-to-create-relay-logic-circuit-with-examples/
［5］ https://realpars.com/plc-timer/#:~:text=PLC%20timers%20are%20internal%20PLC,connected%20to%20wires%20to%20operate

Technology	Electrical
Model Subject	Alternating Current Machines 1
Semester	6th Semester
Subject Code	66761

Perform the Short Circuit Test of a Single Phase Transformer

Electrical Technology (Yellow Team)

Md. Zahidul Haque, Chief Instructor, KPI
Nargis Sultana, Workshop superintendent, DPI
Md. Sharifur Rahman, Lecturer, TTTC
Nasima Khanam, Instructor, DPI

March 2022

Name of the Experiment:
Perform the short circuit test of a single phase transformer.

1. Objectives:

a) To determine the copper loss occur on the full load. The copper loss is used for finding the efficiency of the transformer.
b) To determines equivalent resistance,equivalent impedance, and Equivalent reactance are known by the short circuit test.
c) To know about short circuit test of a single phase transformer.

2. Theory/Principle:

In Short Circuit test, the primary or High Voltage (HV) winding is connected to the AC supply source through voltmeter, ammeter, wattmeter and a variac as shown in figure. This test is also called as Reduced Voltage Test or Low Voltage Test. As the secondary winding is short circuited, at rated voltage, the transformer draws a very large current due to its very small winding resistance.

Let,
Equivalent Resistance = R_{01} , Equivalent Reactance = X_{01} ,
Equivalent Impedance = Z_{01} , Short circuit power = W_{sc}, Short circuit voltage = V_{sc} ,
Short circuit current = I_{sc} and Power factor = $Cos\phi$

Here,
The total resistance at primary winding is ($R_1 + R_2/K^2$) which is known as the "Equivalent Resistance" of the transformer as referred to primary and It may be demarked as $\boldsymbol{R_{01}= R_1+ R_2' = R_1 +R_2/K^2}$. (where K = voltage transformation ratio of the transformer).
Similarly, $\boldsymbol{X_{01}=X_1+ X_2' = X_1 +X_2/K^2}$.
$\boldsymbol{Z_{01}= Z_1+ Z_2' = Z_1 + Z_2/K^2}$.

$Z_{01} = \frac{V_{sc}}{I_{sc}}$ [Ω] $R_{01} = \frac{W_{sc}}{I_{sc}^2}$ [Ω]

$X_{01} = \sqrt{Z_{01}^2 - R_{01}^2}$ [Ω]

$W_{sc} = I_{sc}^2 R_{01}$ [W] $\text{Cos}\phi = \frac{W_{sc}}{V_{sc} I_{sc}}$

2.1 Impedance vector:

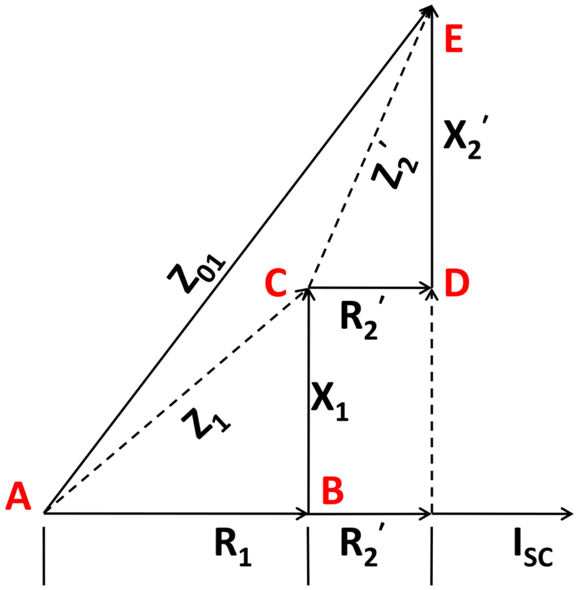


Fig.1 Impedance vector diagram

3. Experiment Method:

Using Demonstrate Method.

3.1 Experiment Apparatus:

1. Transformer (Single phase, 220/110V, 200VA)	.... 1Pc.
2. Wattmeter (0-200W, AC)	.... 1Pc.
3. Ammeter (0-5A, AC)	.... 1Pc.
4. Voltmeter (Multi Range, AC)	.... 1Pc.
5. Variac(Variable ac supply)	.... 1Pc.
6. Screwdriver set	.............1 set
7. Combination Pliers	.............1Pc.
8. Electrician knife	.............1Pc.
9. PVC Wire (4rm)	.............5 mtr
10. Flexible Wire (0.4rm)	.............5 mtr
11. Insulating Tape	.............1Pc.

3.2 Circuit Diagram:

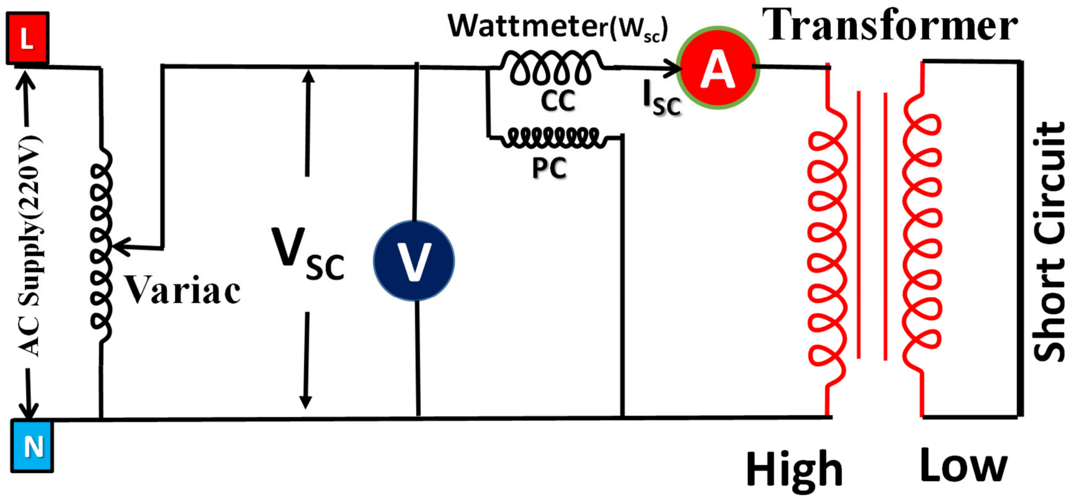


Fig. Short circuit test

3.3 Precaution:

1) Do not put on the supply until the circuit is checked by concerned person.
2) Do not touch any live part of circuit.
3) Be careful for primary & secondary winding rated current.

3.4 Risk during Short circuit test:

Short circuits are a major type of electrical accident that can cause serious damage to electrical system. They occur when a low-resistance path not suited to carry electricity receives a high-volume electrical current. The result of a short circuit can be appliance damage, electrical shock, or even a fire.

4. Experimental Procedure:

In Short Circuit (SC) test, the primary or High Voltage (HV) winding is connected to the AC supply source through voltmeter, ammeter, wattmeter and a variac as shown in figure. Secondary winding is short circuited, at rated voltage, the transformer draws a very large current due to its very small winding resistance.

Such high current can cause overheating and also burning of the transformer. Thus, to limit the high current, the primary winding must be energized with a low voltage, which is just enough to produce the rated current in the primary of the transformer.

The Short Circuit test is conducted on High voltage (HV) side due to the two main reasons. The first one is, the SC test conducted by applying rated current and the rated current of the High voltage side is much less than that of the Low voltage (LV) side. Therefore, the rated current is easily achieved at HV side (due to the low current value) as compared to the LV side.

During this test, by varying the variac slowly, we apply a low voltage to the primary typically 3 to 10 % of the rated voltage to cause a rated current to flow in both primary and secondary windings that we can observe on ammeter reading (in some cases, the secondary is shorted through an ammeter).

5. Data Table/Results:

Sl.	Meter reading			R_{01}	Z_{01}	X_{01}	**Cosϕ**	Remarks
	W_{sc} **[W]**	V_{sc} **[V]**	I_{sc} **[A]**					

6. Discussion:

As we have seen that, the practical transformer has two types of major losses namely copper and core losses. The temperature of the transformer rises due to these losses which are dissipated as heat. Due to these losses, input power drawn by the primary no longer equal to the output delivered at secondary. Therefore, the efficiency of the transformer is given as

$$\text{Efficiency, } \eta = \frac{\text{Power output in [KW]}}{\text{Power input in [KW]}}$$

References:

Sources including the following References:

Books: 1. A Text Book of Electrical Technology --------- B.L Theraja

2. Alternating Current Machine ----------- Siskind

3. Wave sites

Electronics Technology

Technology	Electronics
Model Subject	Microcontroller & Embedded System
Semester	6th Semester
Subject Code	66864

LED Blinking by using Arduino UNO

Electronics Technology (Blue Team)

Saida Momtaz Zubaida Iqbal, HoD, DMPI
Shuvo Das Gupta, Lecturer, TTTC
Bharati Biswas, Instructor, DMPI

March 2022

EXPT NO: 01

Name of The Expt.: LED Blinking by using Arduino UNO.

Objective:

By the end of the session learner will be able to -

- Use Arduino UNO to make 4 LED's blinking.
- Open Arduino IDE for PIC to program the code and build it to produce the hex file.
- Connect LEDs to microcontroller to see them work.

Theory:

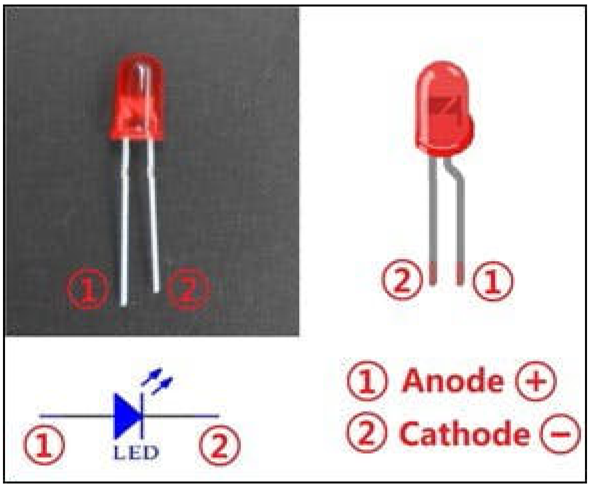
In this lesson, we will program the Arduino's GPIO output high level (+5V) and low level (0V), and then make the LED which is connected to the Arduino's GPIO flicker with a certain frequency.

1. What is the LED:

The LED is the abbreviation of light emitting diode. It is usually made of gallium arsenide, gallium phosphide semiconductor materials.

The LED has two electrodes: a positive electrode and a negative one. It lights up only when a forward current passes, and it can flash red, blue, green, yellow, etc. The colour of the light depends on the material it is made.

In general, the drive current for LED is 5-20mA. Therefore, in reality it usually needs an extra resistor for current limitation so as to protect the LED.

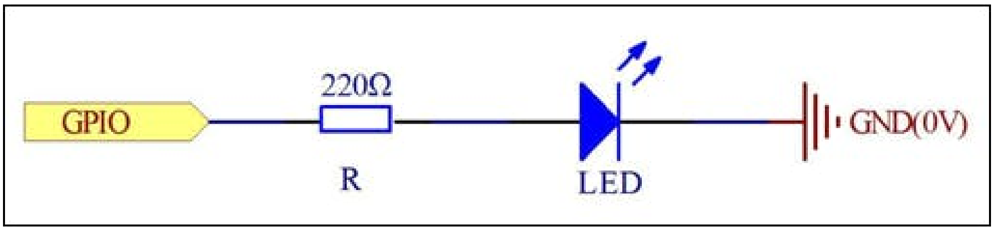


2. What is resistor?

The main function of the resistor is to limit currents. In the circuit, the character 'R' represents resistor, and the unit of resistor is ohm(Ω).

A band resistor is used in this experiment. It is a resistor with a surface coated with some particular colour through which the resistance can be identified directly.

There are two methods for connecting LED to pins of an Arduino board:



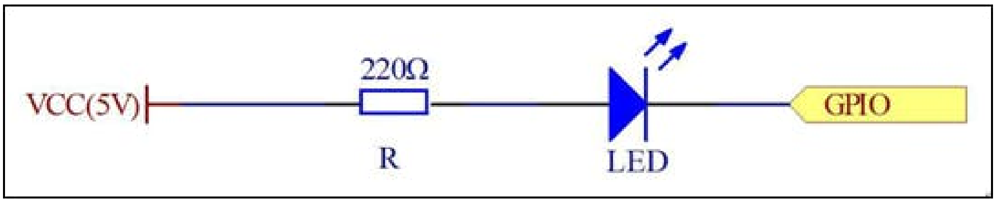
As shown in the schematic diagram, the anode of the LED is connected to Arduino's GPIO via a resistor, and the cathode to the ground (GND). When the GPIO outputs high level, the LED is on; when it outputs low, the LED is off.

The resistance of a current-limiting resistor is calculated as follows: 5~20mA current is required to make an LED on, and the output voltage of the Arduino UNO's GPIO is 5V, so we can get the resistance:

R = V / I = 5V / (5~20mA) = 250Ω~1Kω

For RED Resistor R=Vcc-Vf/(5-20mA) =5-1.8/20mA=0.16kohm

Since an LED is a resistor itself, here we use a 220ohm resistor.



As shown in the schematic diagram above, the anode of LED is connected to VCC(+5V), and the cathode of LED is connected to the Arduino's GPIO. When the GPIO output low level, the LED is on; when the GPIO output high level, the LED is off.

The experiment is made based on method 1 – use pin D8 of the Arduino board to control an LED. When D8 is programmed to output high level, the LED will be turned on. Next, delay for some time. Then D8 is programmed to output low level to turn the LED off. Repeat the above process and you can get a blinking LED then.3.

Principle:

Void Setup: When the program starts:

1. Variables that you create on top of the program will be declared/initialized.
2. The setup function will be called once.
3. All the code you've written inside this function will be executed. After that, the setup function exits.

Void Loop:

1. Now the loop function will be called, so all the code inside the loop will be executed.
2. When the loop function exists, go back to step 1.

Pin Mode:

It instructs the specified pin to behave either as an input or an output. See the Digital Pins page for details on the functionality of the pins.

Delay:

Pauses the program for the amount of time (in milliseconds) specified as parameter. (There are 1,000 milliseconds in a second.)

Digital Write:

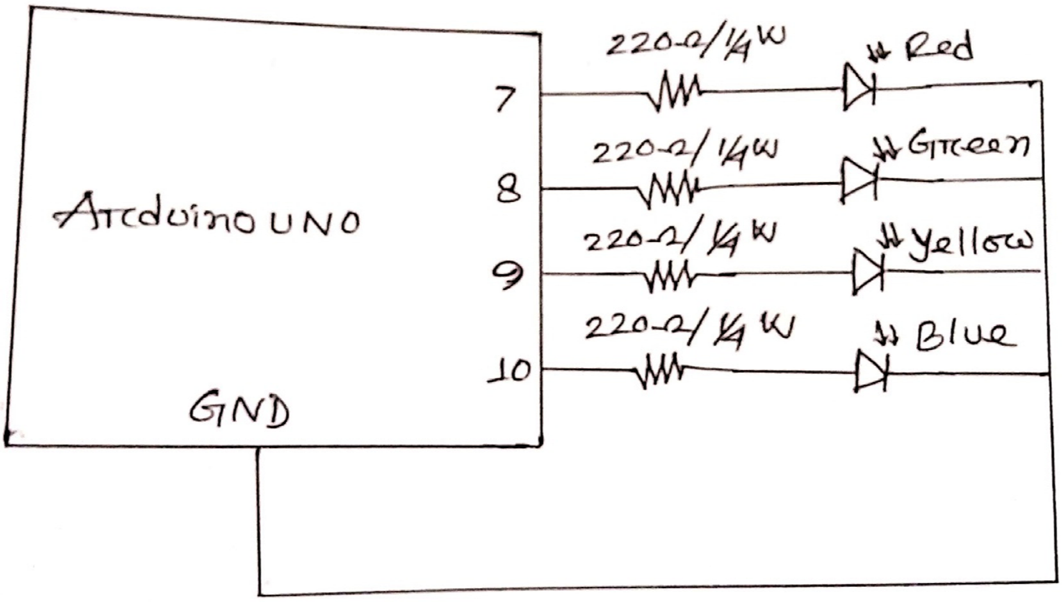
Write a high or a low value to a digital pin.

If the pin has been configured as an OUTPUT with pin Mode(), its voltage will be set to the corresponding value: 5V (or 3.3V on 3.3V boards) for HIGH, 0V (ground) for LOW.

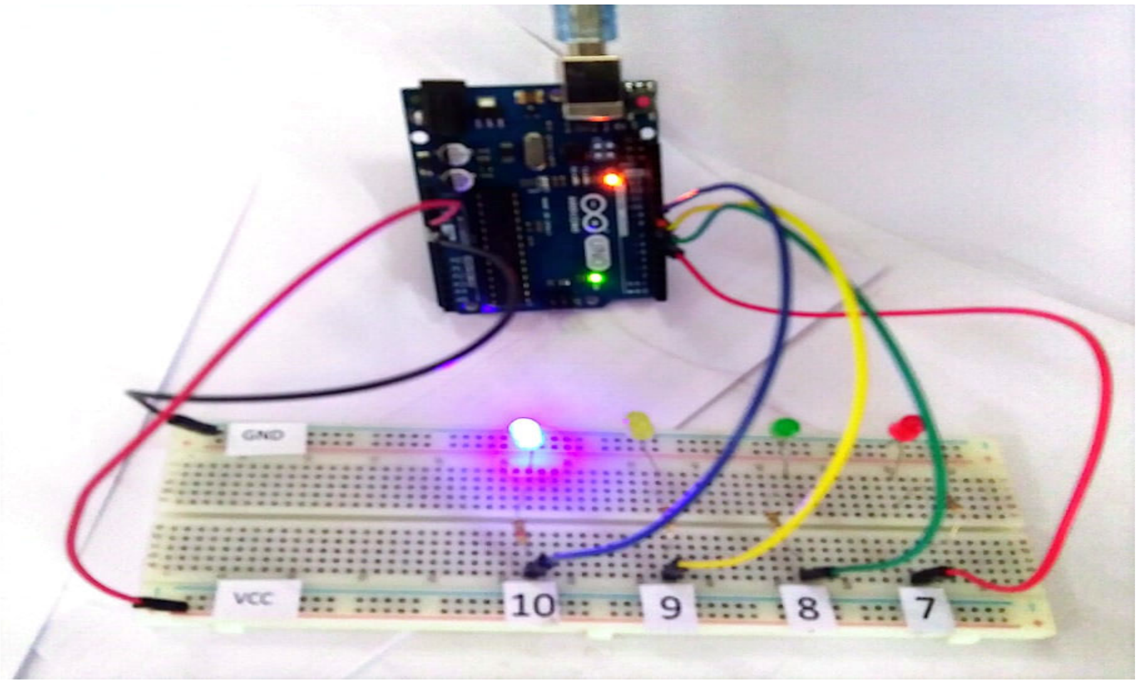
Components Required:

1. LED (Red, Green Yellow, Blue)…...…………………………………..04
2. Bread Board……………..……………………………………………..01
3. Arduino software(Arduino IDE)
4. Proteus Professional software.
5. Laptop/ pc
6. 1 x Arduino Uno……...………………………………………………..01
7. Connecting Wire
8. Resistor 220 Ω 1/4W..……………………………….….….……..04
9. Bread Board……………………………………………………………01

Experimental Circuit:



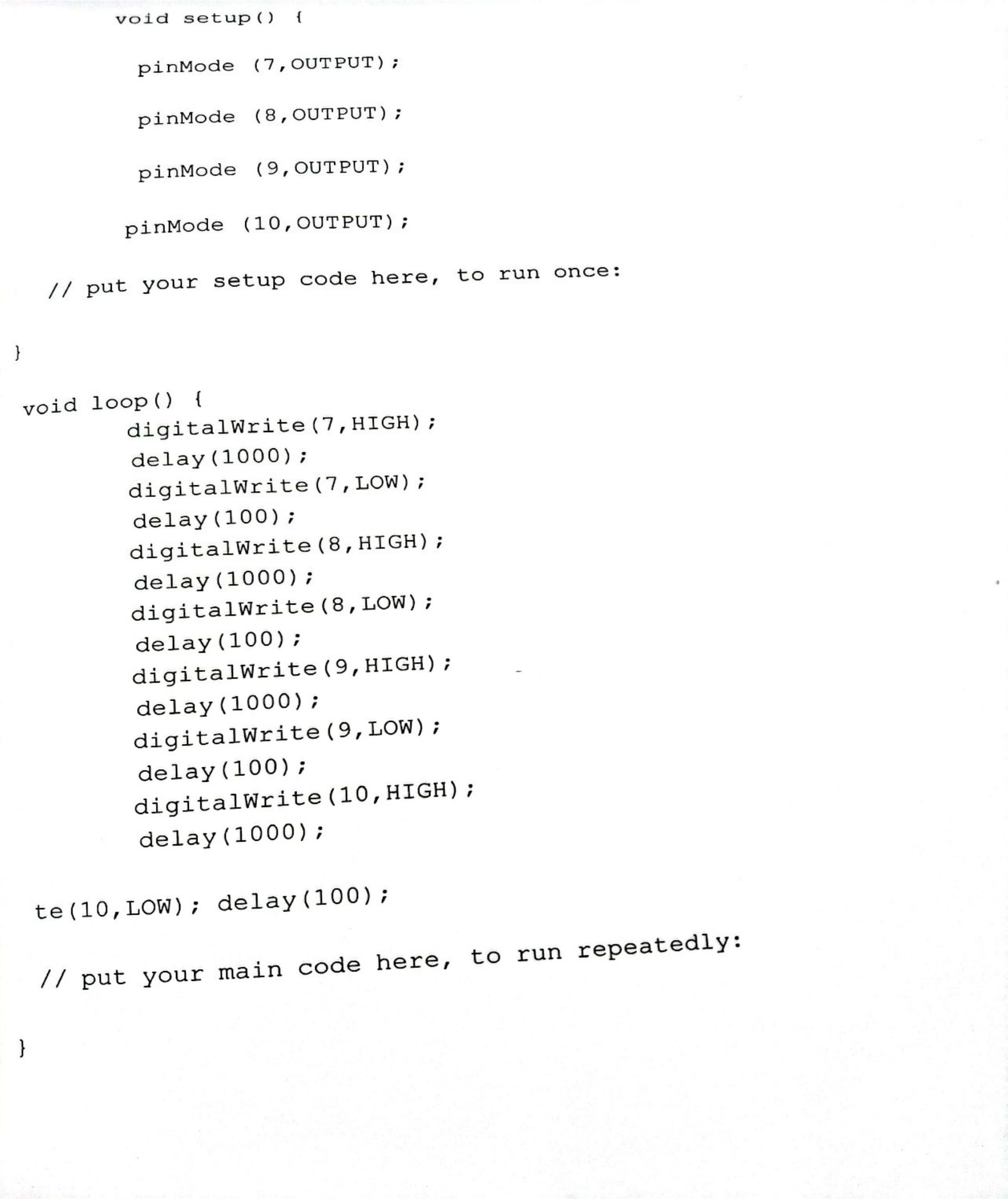
CIRCUIT DIAGRAM:



Use Various Color Of LED ,220 Ohm .25 Watt Resistor

Color of LED	Drop Voltage Across Resistor	Forward Voltage	Forward Currient
Red	1.63-2.03	1.8	0.0081A
Green	1.9	2.2	0.01A
Yellow	2.10-2.18	2	0.009A
Blue	3.2	3.2	0.0145A

PROGRAM:



```
        void setup() {

          pinMode (7,OUTPUT);

          pinMode (8,OUTPUT);

          pinMode (9,OUTPUT);

         pinMode (10,OUTPUT);

   // put your setup code here, to run once:

}

void loop() {
        digitalWrite(7,HIGH);
        delay(1000);
        digitalWrite(7,LOW);
        delay(100);
        digitalWrite(8,HIGH);
        delay(1000);
        digitalWrite(8,LOW);
        delay(100);
        digitalWrite(9,HIGH);
        delay(1000);
        digitalWrite(9,LOW);
        delay(100);
        digitalWrite(10,HIGH);
        delay(1000);

  te(10,LOW); delay(100);

  // put your main code here, to run repeatedly:

}
```

Experiment Procedure:

1.Write the program in Arduino IDE.

2.Connect the arduino pin 7,8,9,10 with Resistor & LED on Bread Board.

3..Load the program in Arduino.

4.Run the program and show the output.

Result:

Based on this program, which LED glown faster? Describe what was happen after running the program.

Discussion:

We have seen that the output result of our experiment is completely match with our objective.

- Tell what will happen if we increase or decrease the delay in the program
- What will happen if we change the pin mode sequence to 10,9,8,7
- What Changes are need to be made in coding to make a left shift of the LED Blinking.
- At which Value of resistor LED will not glow even if the input is high.
- What will heppen if delay is set to 1.

Technology	Electronics
Model Subject	Microcontroller & Embedded System
Semester	6th Semester
Subject Code	66864

Develop and Test a Program for Displaying 0 to 6 on 7-segment display

Electronics Technology (Green Team)

Tahera Binta Karim, Instructor, DMPI

Dapli Nandy, Junior Instructor, DPI

Mokter Ahmad, Junior Instructor, DPI

March 2022

Title:

Develop and test a program for Displaying 0 to 6 on 7-segment display

Objective:

a) At the end of the lesson student will be able to interface a 7-segment display with Arduino.

b) Student will learn how to program to interface a 7-segment display with Arduino.

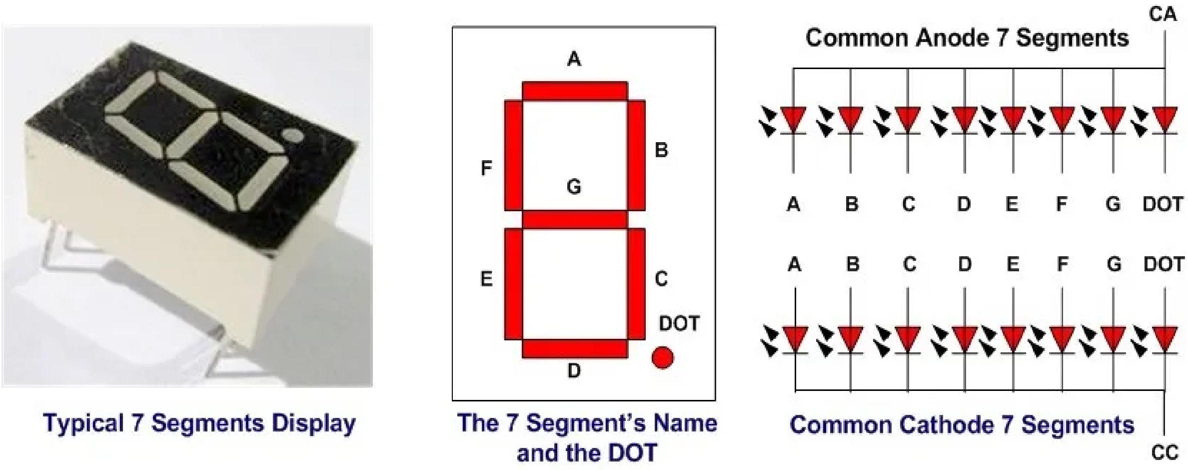
Theory:

7-segments:

Seven-segments are practical, efficient, and cost-effective devices that are used to display alphanumeric numbers.7-segment are uses in digital clock and in digital counter.

This picture below shows a 7-segment display and its pinout. Eight LEDs are internal connection to shows how these LEDs are arranged to make a 7-segment display.

Pin3 and 8 are common pins. These pins are used to provide either 5 volt or ground in common-anode and common cathode type displays respectively.



Typical 7 Segments Display

The 7 Segment's Name and the DOT

Common Anode 7 Segments

Common Cathode 7 Segments

Fig. No: 01

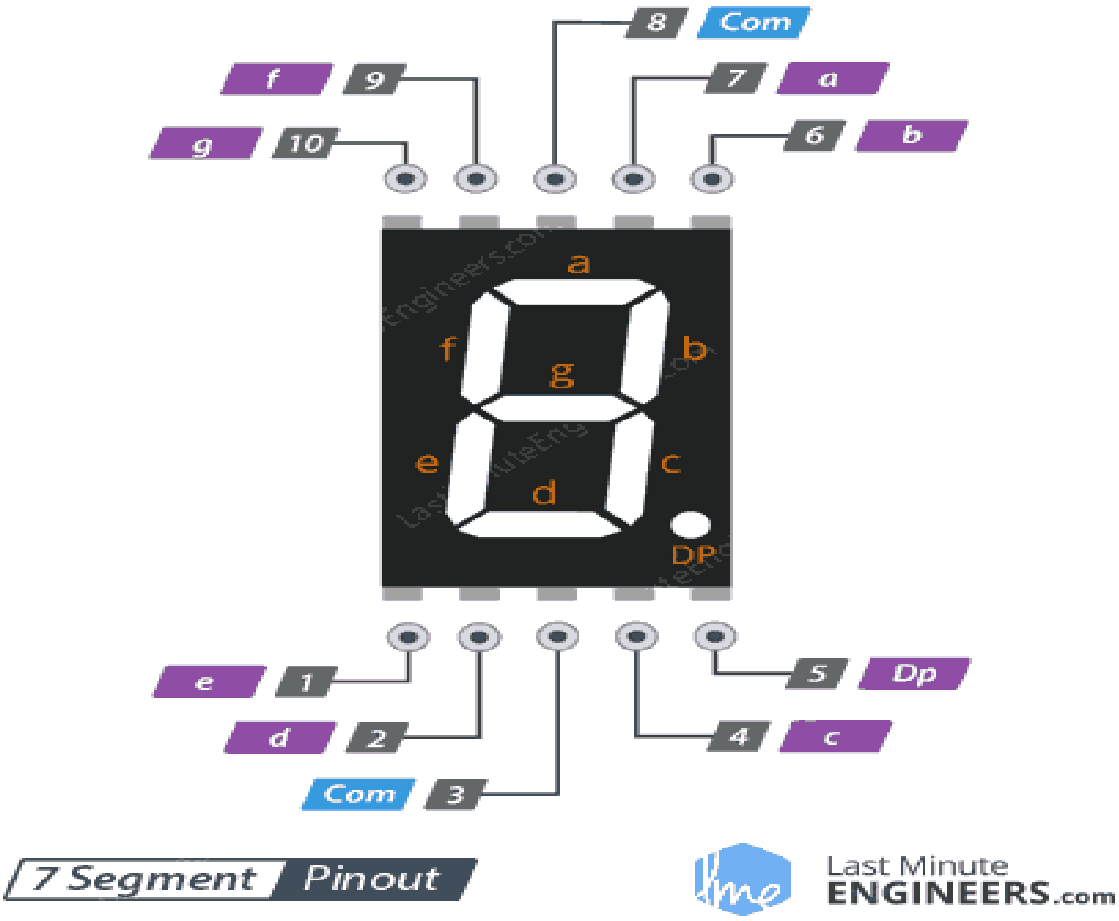


Fig. No: 2

Arduino:

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

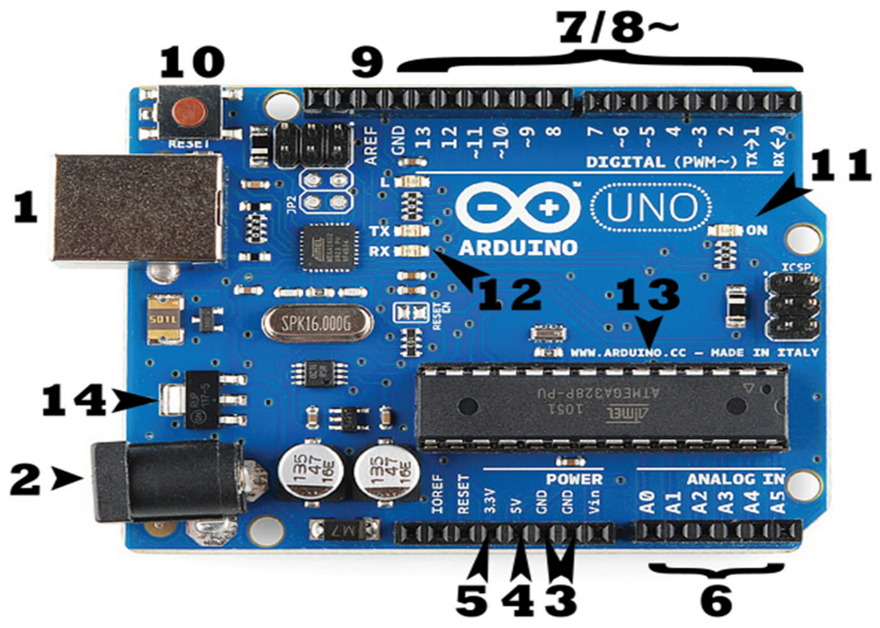


Fig. No : 3

Pins Descriptions:

GND (3): Ground pin on the Arduino.

5V (4) & 3.3V: Arduino run happily off of 5 or 3.3 volts.

Analog (6): (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.

Digital (7): Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM).

AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Components Required:

Hardware:

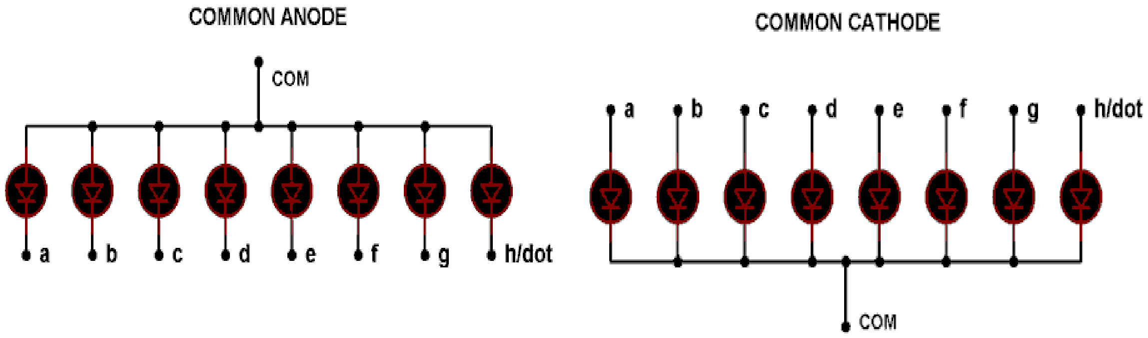
1. ARDUINO UNO,
2. Power supply (5v),
3. HDSP5503 seven segment display (two pieces)
   (Or any common cathode will do),

Software: Arduino IDE (Arduino nightly)

Experiment Procedures:

We are going to interface a seven segment display to ARDUINO UNO. The display counts from 0-6 and resets itself to zero.

A seven-segment display got its name from seven illuminating segments. Each of these segments has a LED (Light Emitting Diode), hence the lighting. The important thing to notice here that the LEDs in any seven-segment display are arranged in common anode mode (common positive) or common cathode mode (common negative).



Internal connections of 7 Segment Display

Fig. No: 04

The circuit connection of LEDs in common cathode and common anode is shown in above figure.

Here one can observe that, in CC the negative terminal of every LED is connected together and brought out as GND.

In CA the positive of every LED is connected and brought out as VCC.

Circuit Diagram and Working Explanation

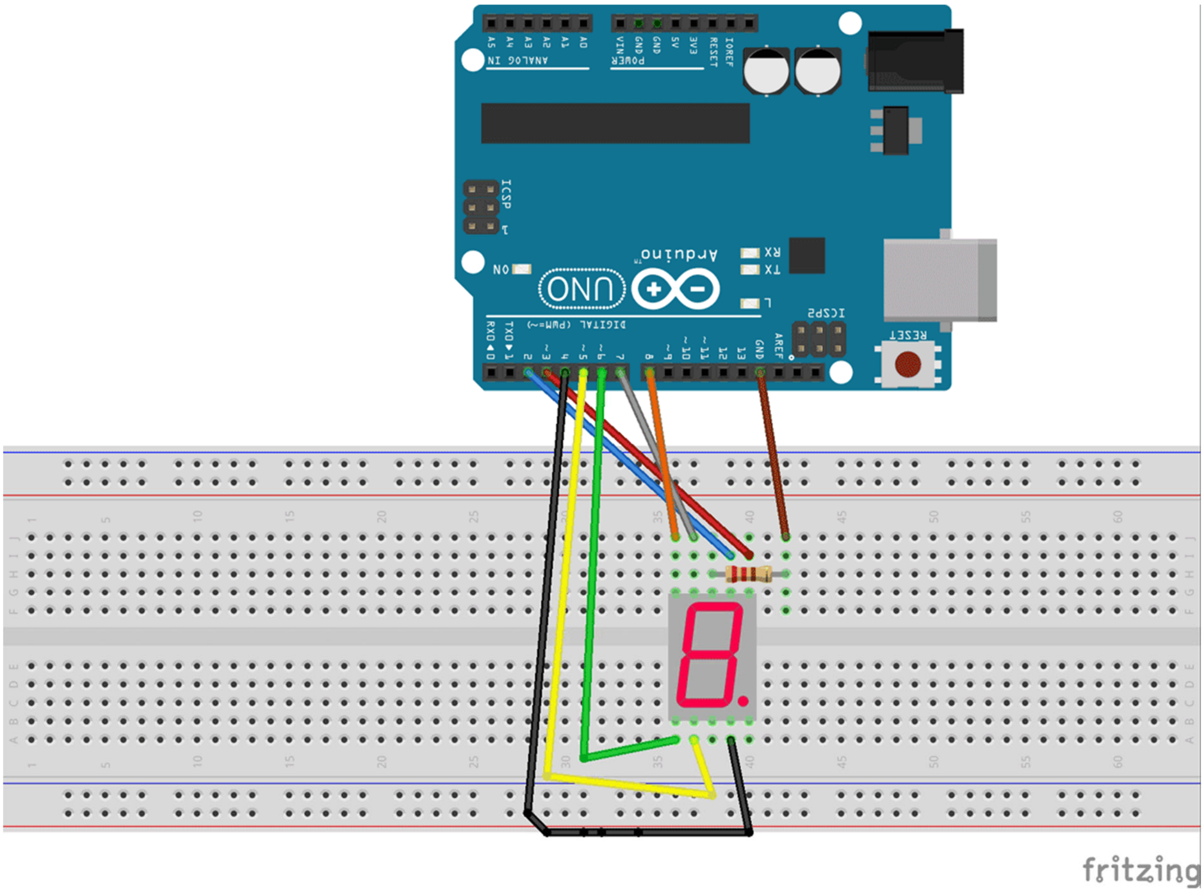


Fig. No: 05

The connections which are done for 7 segment display are given below:

PIN1 or E	to	PIN 6 of ARDUINO UNO
PIN2 or D	to	PIN 5
PIN4 or C	to	PIN 4
PIN5 or H or DP	to	PIN 9 ///not needed as we are not using decimal point
PIN6 or B	to	PIN 3
PIN7 or A	to	PIN 2
PIN9 or F	to	PIN 7
PIN10 or G	to	PIN 8
PIN3 or PIN8 or CC	to	ground through 100Ω resistor.

Now to understand the working, consider a seven-segment display is connected to a port, so say we have connected “A segment of display to PIN0”, “A segment of display to PIN1”, “A segment of display to PIN3”, “A segment of display to PIN4”, “A segment of display to PIN5”, “A segment of display to PIN6”. And is common ground type as shown in figure.

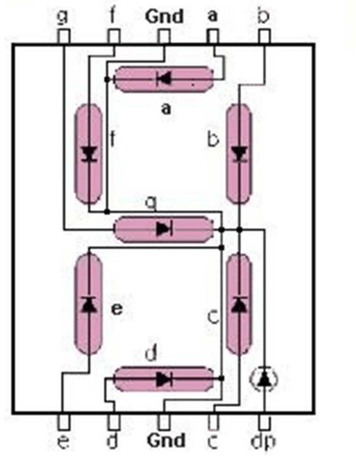


Fig. No: 06

Here the common ground has to be connected to ground for the display to work.

One can check each segment of display by using multimeter in diode mode. Each segment should not be power with a voltage greater than 4v, if did the display will be damaged permanently. For avoiding this a common resistor can be provider at common terminal, as shown in circuit diagram.

Now, if we want to display a “0” in this display as shown in below figure.

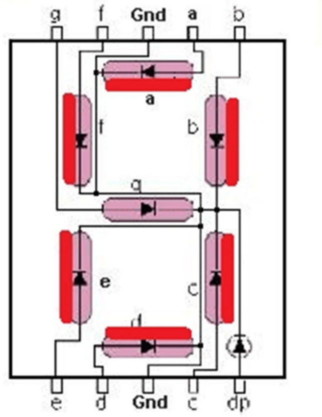


Fig. No : 07

We need to turn the LEDs of segments “A, B, C, D, E F”, so we need to power PIN0, PIN1, PIN2, PIN3, PIN4 and PIN5. So, every time we need a “0”, we need to power all the pins mentioned.

Now, if we want “1” on display

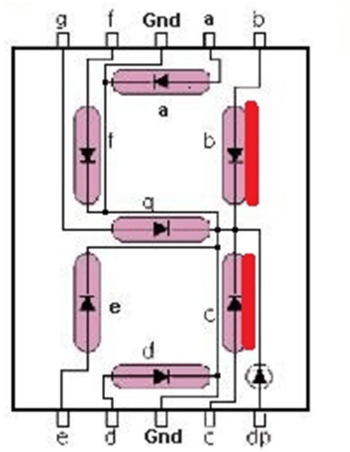


Fig. No : 08

We need to power segments “B, C”, for segment B, C to turn ON we need to power PIN1, PIN2. With both the pins high, we get “1” on display. So as seen above we are going to power pins corresponding to the digit that to be shown on display.

Here we are going to write a program turning each segment ON and OFF for a count 0-6. The working of 0**-6 counter** is best explained step by step in C code given below:

Code

```
#define segA 2                    //connecting segment A to PIN2
#define segB 3          // connecting segment B to PIN3
#define segC 4          // connecting segment C to PIN4
#define segD 5                    // connecting segment D to PIN5
#define segE 6          // connecting segment E to PIN6
#define segF 7          // connecting segment F to PIN7
#define segG 8                    // connecting segment G to PIN8

          int COUNT=0;//count integer for 0-6 increment

void setup()
  {
              for (int i=2;i<6;i++)
              {
                            pinMode(i, OUTPUT);          // taking all pins from 2-8 as output
              }
  }



void loop()
```

```
    {

switch (COUNT)
            {
            case 0:                          //when count value is zero show”0” on disp
            digitalWrite(segA, HIGH);
            digitalWrite(segB, HIGH);
            digitalWrite(segC, HIGH);
            digitalWrite(segD, HIGH);
            digitalWrite(segE, HIGH);
            digitalWrite(segF, HIGH);
            digitalWrite(segG, LOW);
            break;

          case 1:                            // when count value is 1 show”1” on disp
            digitalWrite(segA, LOW);
            digitalWrite(segB, HIGH);
            digitalWrite(segC, HIGH);
            digitalWrite(segD, LOW);
            digitalWrite(segE, LOW);
            digitalWrite(segF, LOW);
            digitalWrite(segG, LOW);
            break;


          case 2:                            // when count value is 2 show”2” on disp
            digitalWrite(segA, HIGH);
            digitalWrite(segB, HIGH);
            digitalWrite(segC, LOW);
            digitalWrite(segD, HIGH);
            digitalWrite(segE, HIGH);
            digitalWrite(segF, LOW);
            digitalWrite(segG, HIGH);
            break;

           case 3:                           // when count value is 3 show”3” on disp
            digitalWrite(segA, HIGH);
            digitalWrite(segB, HIGH);
            digitalWrite(segC, HIGH);
            digitalWrite(segD, HIGH);
            digitalWrite(segE, LOW);
            digitalWrite(segF, LOW);
            digitalWrite(segG, HIGH);
            break;




            case 4:                          // when count value is 4 show”4” on disp
            digitalWrite(segA, LOW);
```

```
    digitalWrite(segB, HIGH);
    digitalWrite(segC, HIGH);
    digitalWrite(segD, LOW);
    digitalWrite(segE, LOW);
    digitalWrite(segF, HIGH);
    digitalWrite(segG, HIGH);
    break;

    case 5:                          // when count value is 5 show"5" on disp
    digitalWrite(segA, HIGH);
    digitalWrite(segB, LOW);
    digitalWrite(segC, HIGH);
    digitalWrite(segD, HIGH);
    digitalWrite(segE, LOW);
    digitalWrite(segF, HIGH);
    digitalWrite(segG, HIGH);
    break;


   case 6:                                // when count value is 6 show"6" on disp

    digitalWrite(segA, HIGH);
    digitalWrite(segB, LOW);
    digitalWrite(segC, HIGH);
    digitalWrite(segD, HIGH);
    digitalWrite(segE, HIGH);
    digitalWrite(segF, HIGH);
    digitalWrite(segG, HIGH);
    break           }


                  if (COUNT<7)

    {

                COUNT++;

                delay(1000);          ///increment count integer for every second

    }

                  if (COUNT==7)

    {

                COUNT=0;       // if count integer value is equal to 7, reset it to zero.

                delay(1000);

    }

 }
```

Result:

Based on the experiment, describe what was happen.

Question:

1. What will be the program for number 7?
2. What will be the program for number 8?
3. What will be the program for number 9?

References:

Reference: documentation of the Arduino programming language and functions.

Hardware: descriptions of the various Arduino boards and other hardware, with schematics, PCB layout files, assembly instructions, etc.

Language comparison: compares the Arduino/Wiring language (based on C/C++) with Processing (based on Java).

Technology	Electronics
Model Subject	Microcontroller & Embedded System
Semester	6th Semester
Subject Code	66864

Program for Rotating a Stepper Motor Clockwise at X°/sec Using Arduino Uno

Electronics Technology (Red Team)

Shanjida Shahnaz, Assistant Professor, TTTC
Md. Rafiquzzaman Khan, Chief Instructor, Khulna Polytechnic Institute
Umme Sadia Irin, Junior Instructor, DMPI

March 2022

1. Objectives

- Describing the basic working principle of stepper motor.
- Conception about the pinout diagram of arduino uno & stepper motor driver.
- Observing the process of arduino IDE software installation.
- Perspicacity the interfacing and controlling of stepper motor at a desired angle.

2. Theory

A stepper motor is a brushless D.C. motor that divides the full rotation angle of 360° into a number of equal steps. There is rotor placed in the form of permanent magnets with two, three or four sets of coils called phases, the stator placed in around the rotor. The windings are connected to an external logic driver which delivers voltage pulses to the windings sequentially. The motor responds to these pulses and performs start, stop, and reverse operations under command. Both the rotor and stator have a definite number of teeth to suit the designed step angle. The Stepper Motors are manufactured with steps per revolution of 12, 24, 72, 144, 180, and 200, resulting in stepping angles of 30, 15, 5, 2.5, 2, and 1.8 degrees per step. The stepper motor can be controlled with or without feedback.

Figure1: Stepper Motor

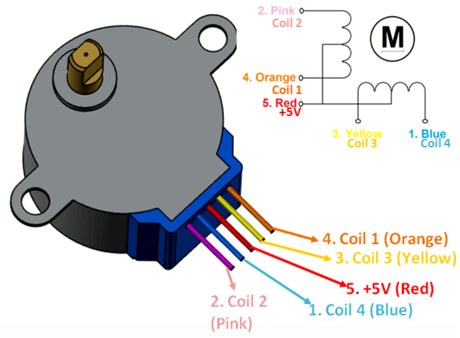


Figure 2: 28BYJ-48 step motor pinout wiring

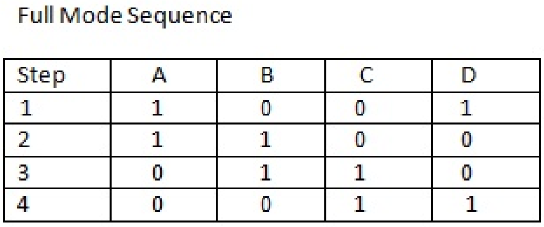
Features: The 28BYJ-48 is a small, cheap, 5 volt geared stepping motors.
Diameter: 28mm
Voltage: 5VDC
Stepping angle: 5.625 x 1/64
Reduction ratio: 1/64
Number of Phase : 4
DC resistance : 50Ω±7%(25°C)
Idle In-traction Frequency : > 600Hz
Idle Out-traction Frequency : > 1000Hz
In-traction Torque >34.3mN.m(120Hz)
Self-positioning Torque >34.3mN.m
Friction torque : 600-1200 gf.cm
Pull in torque : 300 gf.cm
Insulated resistance >10MΩ(500V)
Insulated electricity power : 600VAC/1mA/1s
Insulation grade : A
Rise in Temperature <40K(120Hz)
Noise <35dB(120Hz,No load,10cm)

Step Sequence of Stepper Motor:

Stepper motors can be driven in two different patterns or sequences. Namely,

- Full Step Sequence
- Half Step Sequence

Full Step Sequence: In the full step sequence, two coils are energized at the same time and motor shaft rotates. The order in which coils has to be energized is given in the table below.

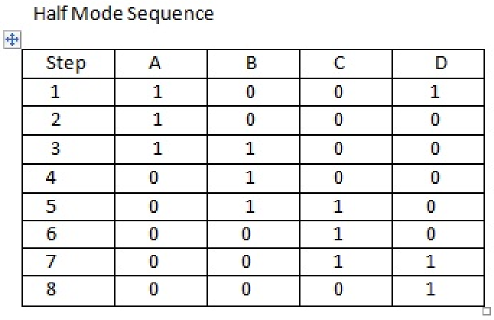


Full Mode Sequence

Step	A	B	C	D
1	1	0	0	1
2	1	1	0	0
3	0	1	1	0
4	0	0	1	1

Table 1: Full Step Sequence

Half Step Sequence: In Half mode step sequence, motor step angle reduces to half the angle in full mode. So the angular resolution is also increased i.e. it becomes double the angular resolution in full mode. Also in half mode sequence the number of steps gets doubled as that of full mode. Table below shows the pattern of energizing the coils.



Half Mode Sequence

Step	A	B	C	D
1	1	0	0	1
2	1	0	0	0
3	1	1	0	0
4	0	1	0	0
5	0	1	1	0
6	0	0	1	0
7	0	0	1	1
8	0	0	0	1

Table 2: Half Step Sequence

Step Angle: Step angle of the stepper motor is defined as the angle traversed by the motor in one step. To calculate step angle, simply divide 360 by number of steps a motor takes to complete one revolution. As we have seen that in half mode, the number of steps taken by the motor to complete one revolution gets doubled, so step angle reduces to half.

As in above examples, Stepper Motor rotating in full mode takes 4 steps to complete
a revolution, So step angle can be calculated as
Step Angle ø = 360° / 4 = 90°
and in case of half mode step angle gets half so 45°.

So this way we can calculate step angle for any stepper motor. Usually step angle is given in the spec sheet of the stepper motor you are using. Knowing stepper motor's step angle helps you calibrate the rotation of motor also to helps you move the motor to correct angular position.

Arduino UNO

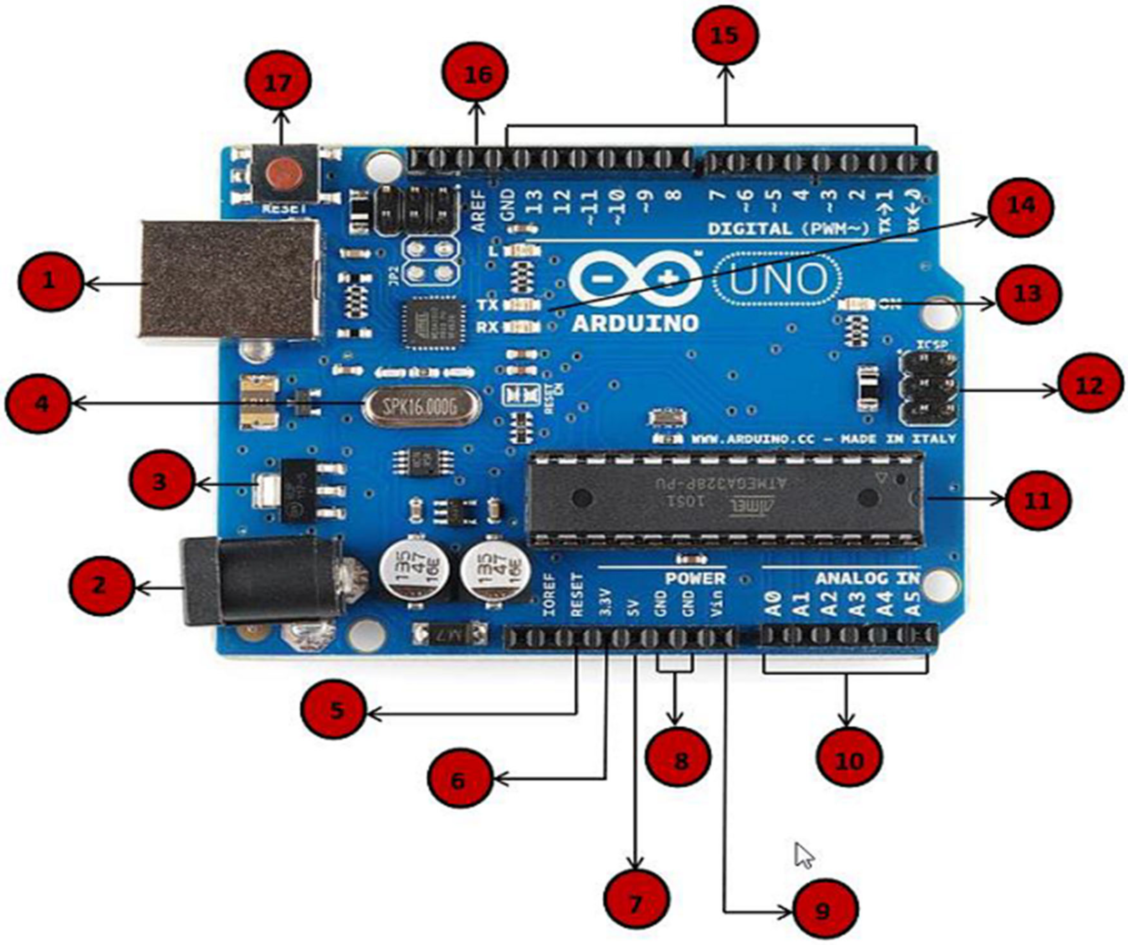


Figure 4: Pinout diagram of Arduino Uno

Description of Pin:

①	**Power USB :** Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).
②	**Power (Barrel Jack) :** Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack (2).
③	**Voltage Regulator:** The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.
④	**Crystal Oscillator:** The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

5,17	**Arduino Reset:** You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).
6,7 8,9	**Pins (3.3, 5, GND, Vin):** 3.3V (6) − Supply 3.3 output volt • 5V (7) − Supply 5 output volt • Most of the components used with Arduino board works fine with 3.3 volt and 5 volt. • GND (8)(Ground) − There are several GND pins on the Arduino, any of which can be used to ground your circuit. • Vin (9) − This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.
10	**Analog pins:** The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.
11	**Main microcontroller:** Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet.
12	**ICSP pin:** Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.
13	**Power LED indicator:** This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.
14	**TX and RX LEDs:** On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

15	**Digital I/O:** The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled "~" can be used to generate PWM.
16	**AREF:** AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

The ULN2003 Driver Board

The motor usually comes with a ULN2003 based driver board. The ULN2003 is one of the most common motor driver ICs, consisting of an array of 7 Darlington transistor pairs, each pair is capable of driving loads of up to 500mA and 50V. Four out of seven pairs are used on this board.The board also comes with an ON/OFF jumper to isolate power to the stepper motor.

The board has a connector that mates the motor wires perfectly which makes it very easy to connect the motor to the board. There are also connections for four control inputs as well as power supply connections. The board has four LEDs that show activity on the four control input lines (to indicate stepping state). They provide a nice visual when stepping.

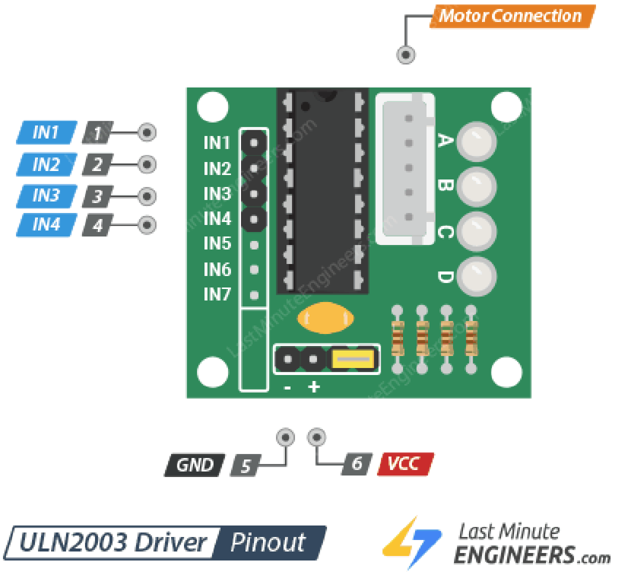


Figure 14: ULN2003 Stepper Driver Board Pinout

Description of Pin:

IN1 – IN4: pins are used to drive the motor. Connect them to a digital output pins on the Arduino.

GND: is a common ground pin.

VDD : pin supplies power for the motor. Connect it to an external 5V power supply. Because the motor draws too much power, you should NEVER use the 5V power from your Arduino to power this stepper motor.

Motor Connector : This is where the motor plugs into. The connector is keyed, so it only goes in one way.

Arduino - Installation

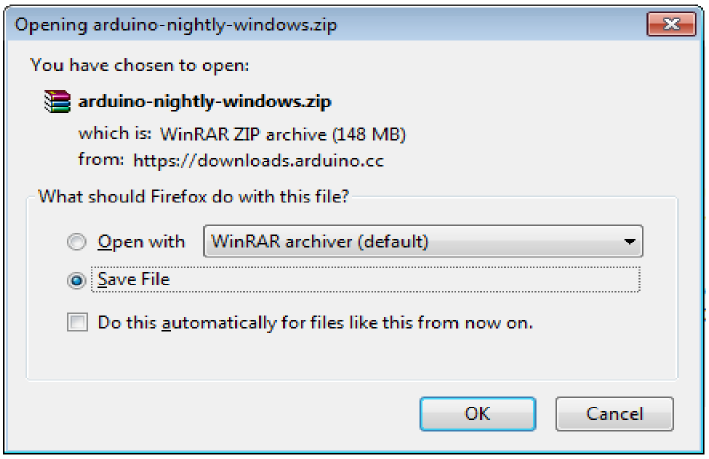
After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

Step 1 − First you must have your Arduino board and a USB cable .You will need a standard USB cable (A plug to B plug).

Figure 5: USB Plug

Step 2 − Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.



Opening arduino-nightly-windows.zip

You have chosen to open:

arduino-nightly-windows.zip

which is: WinRAR ZIP archive (148 MB)

from: https://downloads.arduino.cc

What should Firefox do with this file?

○ Open with WinRAR archiver (default)

● Save File

☐ Do this automatically for files like this from now on.

Figure 6: Downloading of arduino IDE software

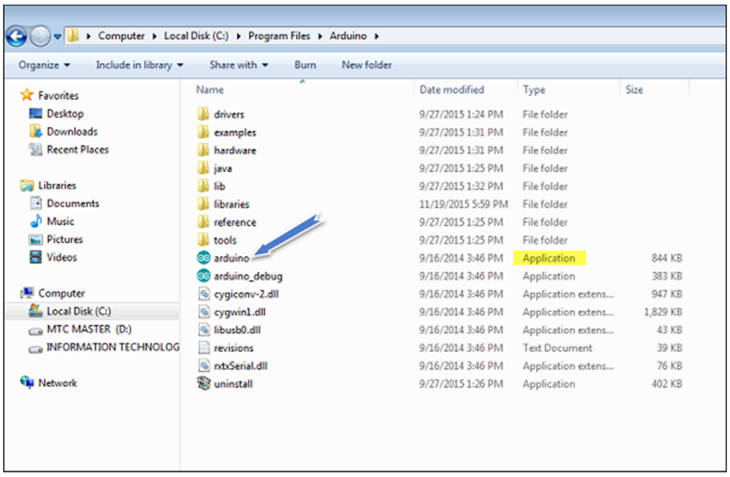
Step 3 − Power up your board.

The Arduino Uno automatically draw power from either the USB connection to the computer or an external power supply. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port.

Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4 − Launch Arduino IDE.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.



Name	Date modified	Type	Size
drivers	9/27/2015 1:24 PM	File folder	
examples	9/27/2015 1:31 PM	File folder	
hardware	9/27/2015 1:31 PM	File folder	
java	9/27/2015 1:25 PM	File folder	
lib	9/27/2015 1:32 PM	File folder	
libraries	11/19/2015 5:59 PM	File folder	
reference	9/27/2015 1:25 PM	File folder	
tools	9/27/2015 1:25 PM	File folder	
arduino	9/16/2014 3:46 PM	Application	844 KB
arduino_debug	9/16/2014 3:46 PM	Application	383 KB
cygiconv-2.dll	9/16/2014 3:46 PM	Application extens...	947 KB
cygwin1.dll	9/16/2014 3:46 PM	Application extens...	1,829 KB
libusb0.dll	9/16/2014 3:46 PM	Application extens...	43 KB
revisions	9/16/2014 3:46 PM	Text Document	39 KB
rxtxSerial.dll	9/16/2014 3:46 PM	Application extens...	76 KB
uninstall	9/27/2015 1:26 PM	Application	402 KB

Figure 7: Launching of arduino IDE

Step 5 − Open your first project.

Once the software starts, you have two options −

- Create a new project.
- Open an existing project example.

To create a new project, select File → **New**.

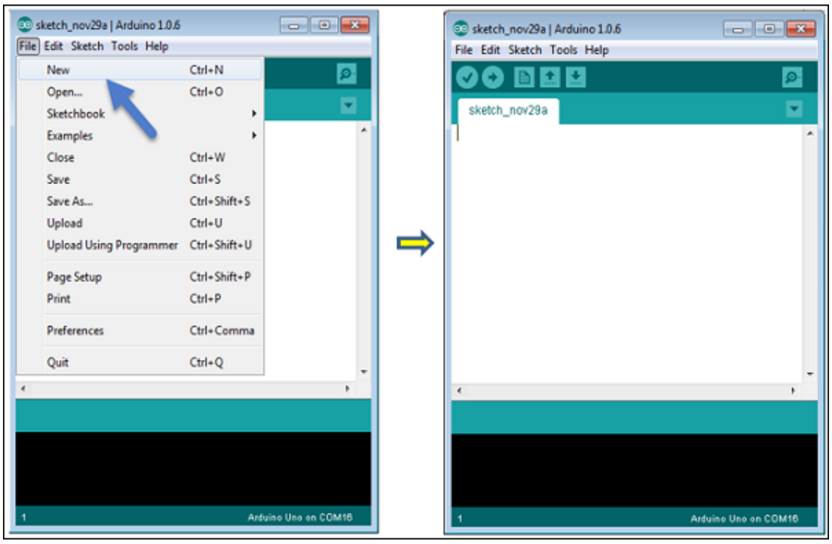
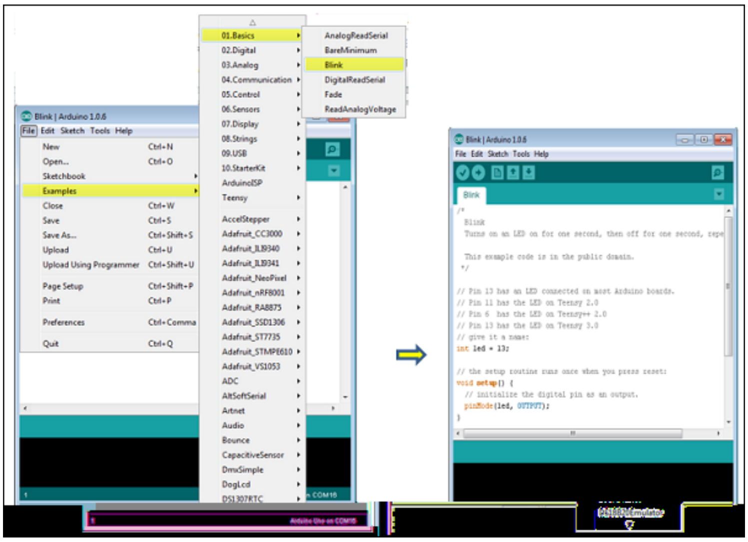


Figure 8: Opening Project

To open an existing project example, select File → Example → Basics → Blink.

Here, we are selecting just one of the examples with the name **Blink**. It turns the LED on and off with some time delay. You can select any other example from the list.



```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repe

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// Pin 11 has the LED on Teensy 2.0
// Pin 6  has the LED on Teensy++ 2.0
// Pin 13 has the LED on Teensy 3.0
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}
```

Figure 9: Opening example

Step 6 − Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools → Board and select your board.

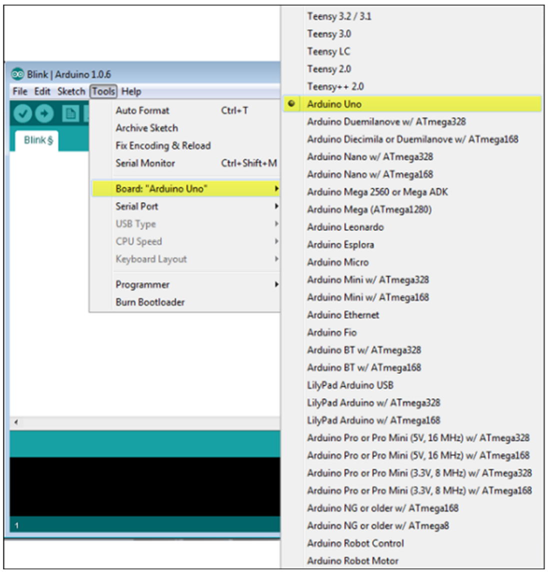


Figure 10: Selecting required arduino board

Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using.

Step 7 − Select your serial port.

Select the serial device of the Arduino board. Go to **Tools → Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

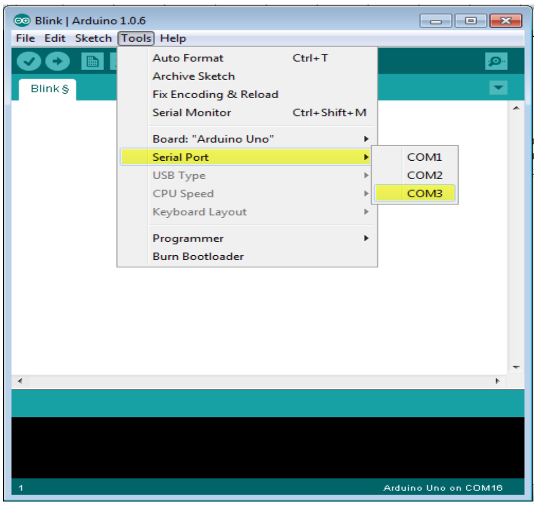


Figure 11: Selecting serial port

Step 8 − Upload the program to your board.

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

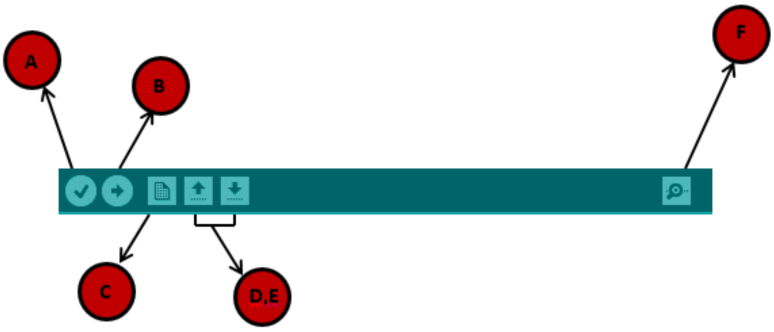


Figure 12: Arduino IDE toolbar

A − Used to check if there is any compilation error.

B − Used to upload a program to the Arduino board.

C − Shortcut used to create a new sketch.

D − Used to directly open one of the example sketch.

E − Used to save your sketch.

F − Serial monitor used to receive serial data from the board and send the serial data to the board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

3. Experiment Apparatus

- Arduino UNO
- Stepper Motor (28 BYJ-48) ,5VDC
- Stepper Motor Driver (ULN2003)
- Power Supply (Appropriate for particular stepper/5V battery)
- USB cable, PC
- Male to male jumper wire
- Arduino IDE software
- Small screw driver

4. Experiment Procedures

Follow the circuit arrangement as shown in the figure 15 and make the connection as:

a) Start by connecting the power supply (battery 5V) up to the ULN2003 driver.
b) Next connect the ground from that power supply to the arduino's ground. This is very important so that we establish the same voltage reference between the two.
c) Now connect the driver board's IN1, IN2, IN3, IN4 to the Arduino digital pins 8, 9, 10, and 11 respectively.
d) Hook the motor cable from the stepper motor up to the driver board.
e) Any digital pins of your choice can be connected to the driver, starting from left for Coil A, B, C, D There are pins for E, F and G too, but we will not be using those for this project.

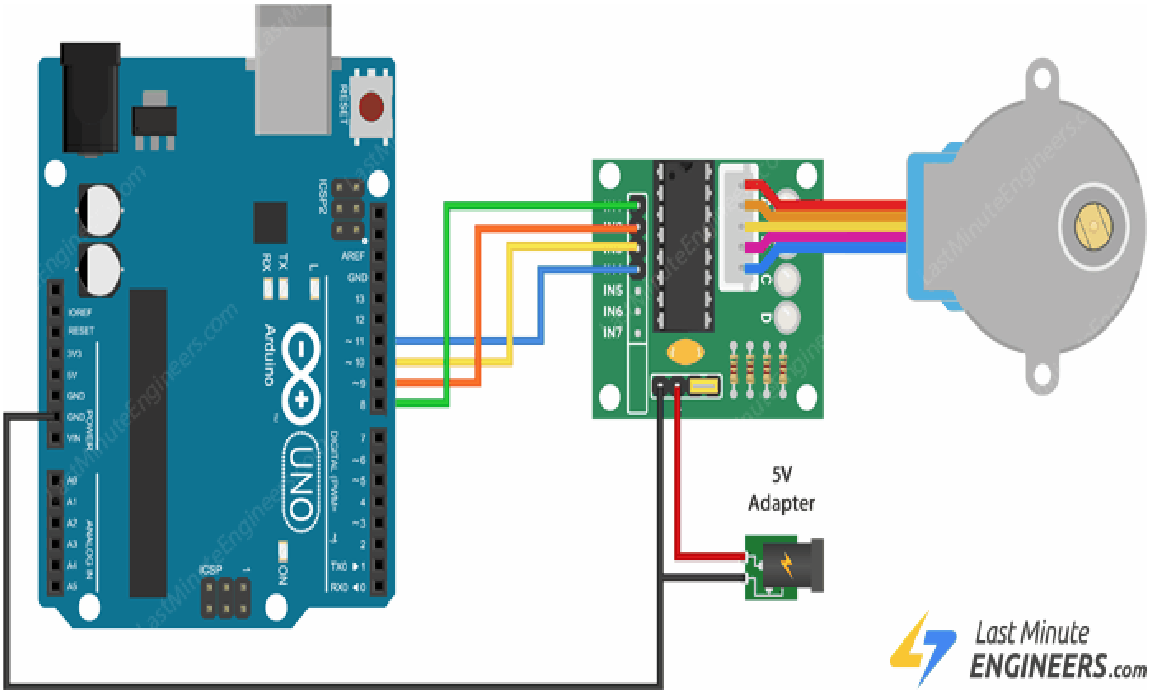


Figure 15: Circuit arrangement

- After above operations are completed, connect the Arduino board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

- Open the Arduino IDE and select corresponding board type and port type for your Arduino board.
- Arduino Code – Using Built-in Stepper Library: For our first experiment we will make use of the Arduino Stepper Library which comes packaged with your Arduino IDE.

Now sketch the Arduino code as follows: Here's the simple sketch that moves the stepper motor clockwise slowly and then counterclockwise quickly.

Code:

```
#include <Stepper.h>
const int stepsPerRevolution = 2038;
Stepper myStepper = Stepper(stepsPerRevolution, 8, 10, 9, 11);
void setup() {

}
void loop() {

        myStepper.setSpeed(100);        // Rotate CW slowly
        myStepper.step(stepsPerRevolution);
        delay(1000);
        myStepper.setSpeed(700);      // Rotate CCW quickly
        myStepper.step(-stepsPerRevolution);
        delay(1000);}
```

Code Explanation:

(1) #include <Stepper.h>

The sketch starts with including the Arduino Stepper Library.

(2) const int stepsPerRevolution = 2038; Next, we define a constant stepsPerRevolution which holds the number of 'steps' that the motor will take to complete one revolution. In our case, it's 2038.

(3) Stepper myStepper = Stepper(stepsPerRevolution, 8, 10, 9, 11);

There is nothing to set in the setup function as the Stepper library internally sets the four I/O pins as outputs. The 28BYJ-48 Unipolar stepper motor has a step sequence of IN1-IN3-IN2-IN4. We will use this information to drive the motor by creating an instance of stepper library called myStepper with the pin sequence of 8, 10, 9, 11. Make sure you get this right or the motor will not operate properly.

(4) void setup() { }

In the loop function, we use the setSpeed() function to set the speed that we wish the stepper motor to move and subsequently use the step() function to tell it how many steps to rotate. Passing a negative number to the step() function reverses the spinning direction of the motor. First code snippet will turn the motor clockwise very slowly. And the second will turn the motor counterclockwise at a much faster speed.

(5) void loop() {

```
// Rotate CW slowly
myStepper.setSpeed(100);
        myStepper.step(stepsPerRevolution);
        delay(1000);
```

```
// Rotate CCW quickly
myStepper.setSpeed(700);
        myStepper.step(-stepsPerRevolution);
        delay(1000);}
```

- After compiling the sketch, simply click the “Upload” button in the environment. Wait a few seconds – you should see the RX and TX LED on the board flashing. If the upload is successful, the message “Done uploading.” will appear in the status bar.

5. Result

Based on the experiment, it is shown how to change the direction and speed of rotation to the next step. Now fill in the table below:

Speed	Steps/revolution
200 (cw)	
500 (cw)	
350 (ccw)	
700(ccw)	

6. Discussions

Interfacing, controlling and rotation of the stepper motor is done with Arduino Uno accordingly clock wise & anti clock wise direction. Also the speed can be changed.

1. Why we need driver modules for stepper motor?
2. How to calculate the steps per revolution for stepper motor?
3. Why you use extra 5V battery to powering stepper board?
4. What does mean by 1/64 reduction gear set?
5. How do you change the speed of stepper motor?

7. References

https://circuitdigest.com/microcontroller-projects/arduino-stepper-motor-control-tutorial

https://www.electrical4u.com/interfacing-of-stepper-motor/

https://www.electronicshub.org/stepper-motor-control-using-arduino/

https://www.electronicwings.com/arduino/stepper-motor-interfacing-with-arduino-uno

https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DJyE6rI8tu_A&psig=AOvVaw3NnBDKohmRftRZfEJf4v3r&ust=1637561323997000&source=images&cd=vfe&ved=0CAkQjhxqFwoTCMip1b_lqPQCFQAAAAAdAAAAABAD

https://www.tinkercad.com/things/eBrQkCGoGBf

https://www.tutorialspoint.com/arduino/arduino_stepper_motor.htm

Technology	Electronics
Model Subject	Microcontroller & Embedded System
Semester	6th Semester
Subject Code	66864

Develop and test a Program for Interfacing DC MOTOR

Electronics Technology (Yellow Team)

Md. Nuruzzaman, Chief Instructor & HOD, DPI
Rehana Akter, Chief Instructor & HOD, DMPI

March 2022

Title: Develop and test a Program for Interfacing DC MOTOR.

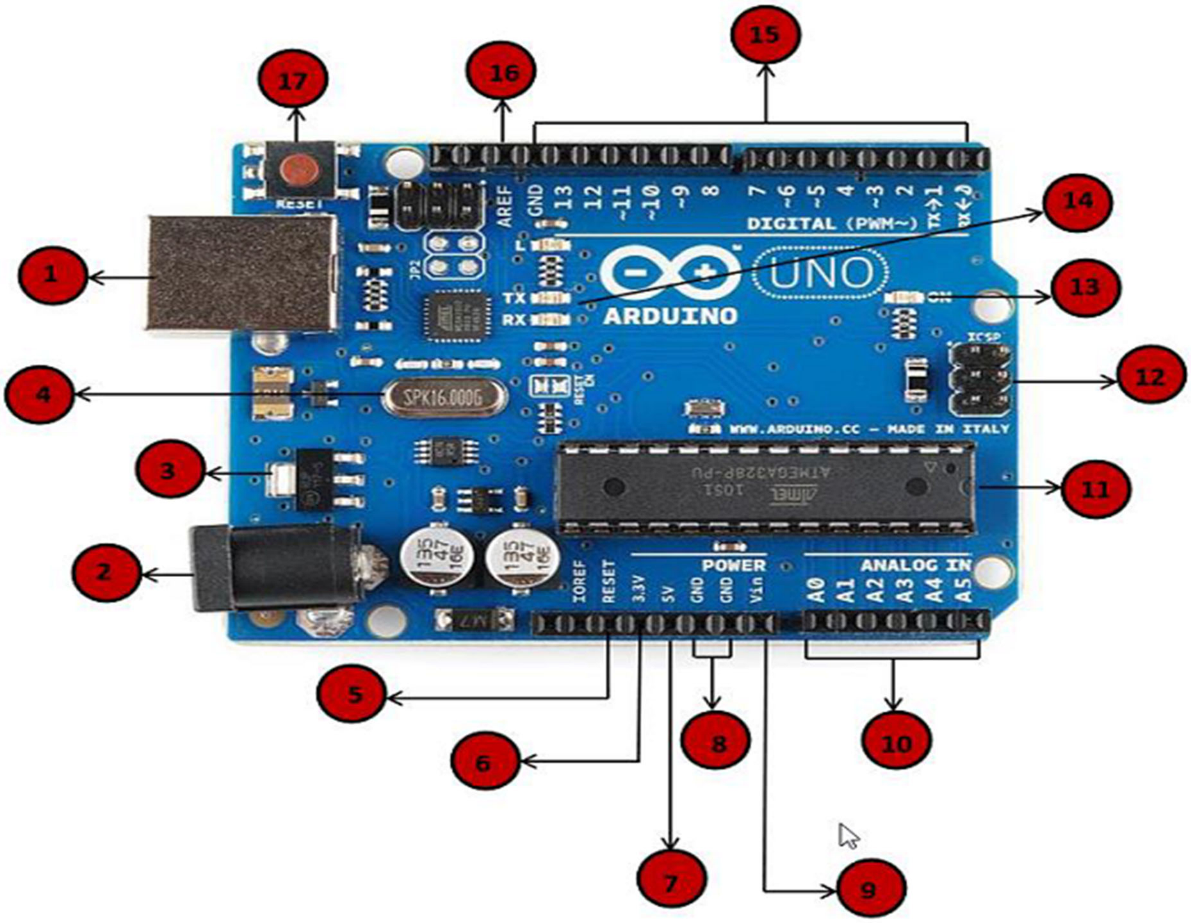
Objective :

a) To know the use of DC Motor.
b) To know the interfacing of DC Motor with Arduino
c) To learn about controlling DC motors

Theory:

One of the easiest and inexpensive way to control DC motors is to interface **L293D Motor Driver IC** with Arduino. It can control both speed and spinning direction of two DC motors.

Arduino Board:



Experiment Apparatus:

1. 2 x DC Motor
2. 1x L293D motor driver module
3. 1x Arduino Nano / Arduino Uno
4. Connecting Wires

Theory:

a) A DC motor (Direct Current motor) is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction.

b) One of the easiest and inexpensive way to control DC motors is to interface **L293D Motor Driver IC** with Arduino. It can control both speed and spinning direction of two DC motors.

Precautions:

- Avoid short circuit.
- Connect components properly.
- Handle the power supply carefully.

Follow the step of experiment properly.

Experiment Procedures:

Wiring L293D motor driver IC with Arduino UNO

- Open Simulation Software (Proteus or other)
- Draw schematic diagram.
- Link compiled hex file for simulation.
- Click play button for start simulation.
- Press Button to test motor rotation & direction.

Now that we know everything about the IC, we can begin hooking it up to our Arduino!

Start by connecting power supply to the motors. In our experiment we are using DC Gearbox Motors (also known as ‘TT’ motors) that are usually found in two-wheel-drive robots. They are rated for 3 to 9V. So, we will connect external 9V power supply to the Vcc2 pin.

Next, we need to supply 5 Volts for the L293D’s logic circuitry. Connect Vcc1 pin to 5V output on Arduino. Make sure you common all the grounds in the circuit.

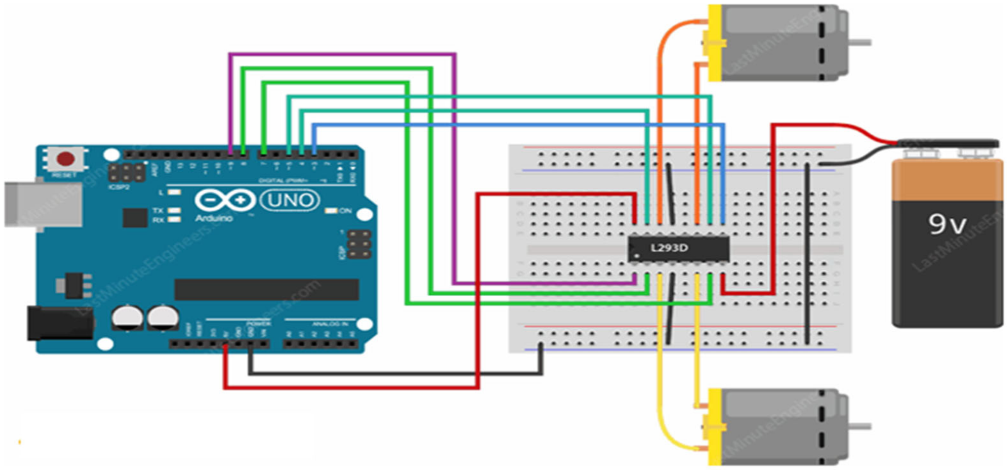
Now, the input and enable pins (ENA, IN1, IN2, IN3, IN4 and ENB) of the L293D IC are connected to six Arduino digital output pins (9, 8, 7, 5, 4 and 3). Note that the Arduino output pins 9 and 3 are both PWM-enabled.

Finally, connect one motor to across OUT1 & OUT2 and the other motor across OUT3 & OUT4. You can interchange your motor's connections, technically, there is no right or wrong way.

When you're done you should have something that looks similar to the illustration shown below.

Descriptions:

- Connect components according to schematic diagram.
- Power up the microcontroller board.
- Develop the program in IDE.
- Compile the program.
- Connect Burner Board to PC.
- Open Burner Software, Browse HEX file and download to microcontroller.



Wiring L293D Motor Driver IC with DC Motors & Arduino

Arduino Code:

```
// Motor A connections
int enA = 9;
int in1 = 8;
int in2 = 7;
// Motor B connections
int enB = 3;
int in3 = 5;
int in4 = 4;

void setup() {
        // Set all the motor control pins to outputs
        pinMode(enA, OUTPUT);
        pinMode(enB, OUTPUT);
        pinMode(in1, OUTPUT);
```

```
        pinMode(in2, OUTPUT);
        pinMode(in3, OUTPUT);
        pinMode(in4, OUTPUT);

        // Turn off motors - Initial state
        digitalWrite(in1, LOW);
        digitalWrite(in2, LOW);
        digitalWrite(in3, LOW);
        digitalWrite(in4, LOW);
}

void loop() {
        directionControl();
        delay(1000);
        speedControl();
        delay(1000);
}

// This function lets you control spinning direction of motors
void directionControl() {
        // Set motors to maximum speed
        // For PWM maximum possible values are 0 to 255
        analogWrite(enA, 255);
        analogWrite(enB, 255);

        // Turn on motor A & B
        digitalWrite(in1, HIGH);
        digitalWrite(in2, LOW);
        digitalWrite(in3, HIGH);
        digitalWrite(in4, LOW);
        delay(2000);

        // Now change motor directions
        digitalWrite(in1, LOW);
        digitalWrite(in2, HIGH);
        digitalWrite(in3, LOW);
        digitalWrite(in4, HIGH);
        delay(2000);

        // Turn off motors
        digitalWrite(in1, LOW);
        digitalWrite(in2, LOW);
        digitalWrite(in3, LOW);
        digitalWrite(in4, LOW);
}

// This function lets you control speed of the motors
void speedControl() {
        // Turn on motors
        digitalWrite(in1, LOW);
        digitalWrite(in2, HIGH);
        digitalWrite(in3, LOW);
        digitalWrite(in4, HIGH);

        // Accelerate from zero to maximum speed
        for (int i = 0; i < 256; i++) {
                analogWrite(enA, i);
                analogWrite(enB, i);
                delay(20);
        }
```

```
 // Decelerate from maximum speed to zero
 for (int i = 255; i >= 0; --i) {
         analogWrite(enA, i);
         analogWrite(enB, i);
         delay(20);
 }

 // Now turn off motors
 digitalWrite(in1, LOW);
 digitalWrite(in2, LOW);
 digitalWrite(in3, LOW);
 digitalWrite(in4, LOW);

}
```

Results:

What would be your observation after the completion of the experiment.

Discussion:

a) What is Microcontroller?
b) What is Arduino?
c) What is DC motor?
d) Write down the motor Driver IC number.
e) Write the use of DC motor.

Mechanical Technology

Technology	Mechanical
Model Subject	Hydraulics & Hydraulic Machineries
Semester	5th Semester
Subject Code	67051

Determination of Loss of Head due to Sudden Enlargement of a Pipe Using a Manometer

Mechanical Technology (Blue Team)

Engr. Abu Hena Md. Shamim Hasan, Assistant Prof., TTTC
Muhammad Farok Hossen Bhuiya, Instructor, DPI
Engr. Muhammad Abdul Mannan Miah, Instructor, DPI

March 2022

Determination of Loss of Head due to Sudden Enlargement of a Pipe using a Manometer

Objectives:

The main objective of this experiment is to investigate the head loss due to sudden enlargement of a pipe using a manometer. Moreover, the principle of static pressure measurement using manometer is to be learned. On completion, the participants will be able to

1) Understand the by using Manometer
2) Understand how to measure the pressure of liquid at different sections in the pipe
3) Understand how to measure the velocity of liquid at different sections in the pipe
4) Estimate the head loss due to sudden enlargement of a pipe flow

Theory:

Consider a liquid flowing in a pipe ABC having a sudden enlargement at B. As a result of this sudden enlargement, eddies will be formed in the corner of the pipe at B as shown in figure.

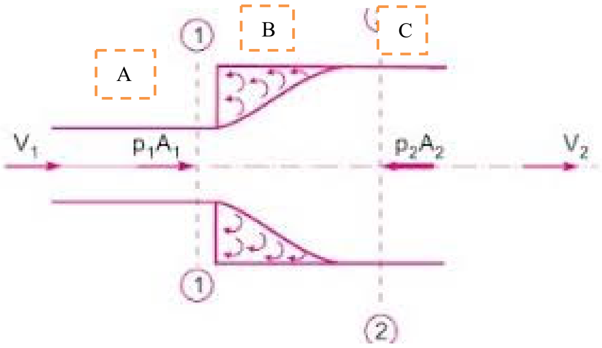


Fig. 1 Sudden enlargement of a pipe[1]

Here,

A_1 = Area of pipe at section 1-1

V_1 =Velocity of the liquidat section 1-1

P_1 = Pressure of the liquid at section 1-1

A_2 = Area of pipe at section 2-2

V_2 =Velocity of the liquidat section 2-2

P_2 = Pressure of the liquid at section 2-2

h_e = loss of head due to sudden enlargement

It has been experimentally found that inlet pressure (P_1) of the liquid at section 1-1 is nearly equal to pressure at liquid eddies area and this is the assumption on which formula for loss of head due to sudden enlargement is derived. As a matter of fact, the loss of head that takes place is due to the eddies formed at the suddenly enlarged section as shown in Fig. 1.

Applying the Bernoulli's equation between sections 1-1 and 2-2

$\frac{P_1}{\omega}+\frac{V_1}{2g}=\frac{P_2}{\omega}+\frac{V_2}{2g}+h_e$ [Here ω is the specific weight of liquid]

The flow rate is given by,

$Q = A_1 V_1 = A_2 V_2$

and loss of head due to sudden enlargement is $h_e = \frac{(V_1 - V_2)^2}{2g}$

Experimental Setup & Procedure

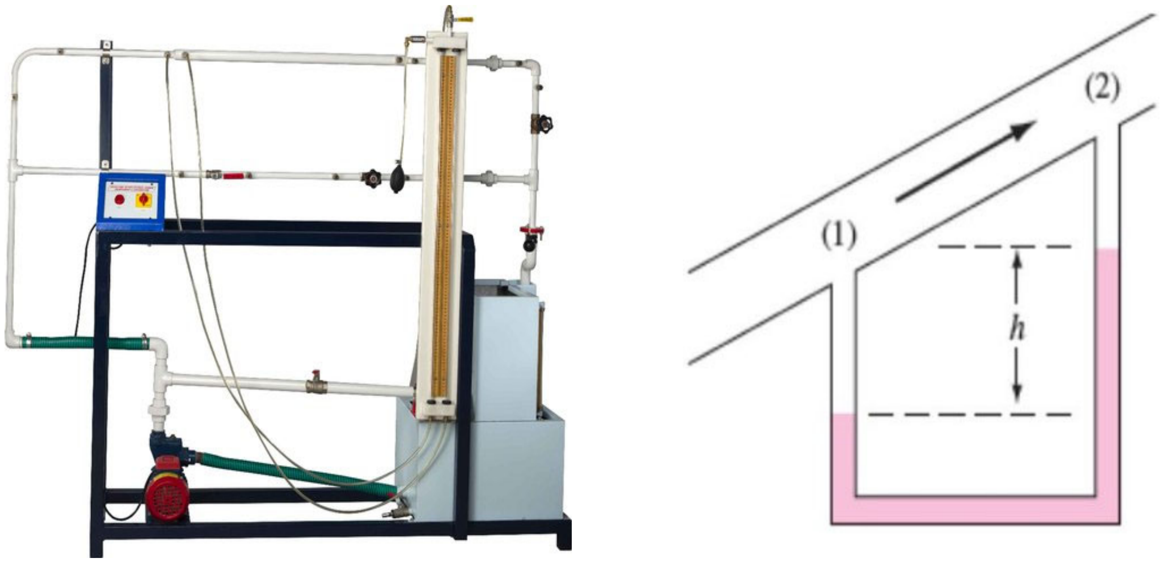
Setup & Materials:

Following materials are required to conduct the experiment.

1) 2 (two) plastic box
2) A small aquarium pump
3) PVC pipe (Ø16 mm & 2 m)
4) Rubber hose pipe (clear, Ø16 mm & 2 m)
5) Silicone sealant with gun
6) Elbow for main hose pipe (Ø16 mm) – as per require
7) Different diameter of pipe, 2 M
8) Joint Two-Way hose fitting (Ø 4 mm) – as per require
9) Clear rigid Acrylic pipe Ø 4 mm
10) Soldering Iron
11) Steel ruler and stopwatch
12) Sealing gape
13) Thread pipe fittings as per require.

Procedure:

1) Build the experimental setup as shown in figure.
2) Fill the lower box with water and turn on the pump so that water flows along the pipe and also re circulates within the system.
3) Measure the height *h* in the U-tube manometer.
4) Use the measuring cup to capture a known volume of water over a measured time and calculate the volume flow rate.
5) Knowing the pipe diameter, and the area of these two sections can be found out
6) U- Tube Manometer is connected to the pressure tapings
7) When the flow becomes steady, the deflection in the manometer is noted
8) The discharge should be varied uniformly to get a good set of observations



(a) Pipe flow setup (b) U-tube Manometer

Fig: 2 Pipe flow setup and U-tube manometer [2]

Observations:

Pipe diameter D_1 at section 1-1 =

Pipe diameter D_2 at section 2-2 =

Specific gravity of flowing liquid ρ =

Specific gravity of manometer liquid ρ_m=

Velocity of flowing liquid V_1 at section 1-1 =

Velocity of flowing liquid V_2 at section 2-2 =

Results:

Experimental Data: Experimentally obtain head loss

Table 1. Data for Determination of Head Loss (h_e)

No. of Obs.	Flow Rate of H_2O Q = AV m^3/ sec	Velocity Flow $V_1 = \frac{Q}{A_1}$ m /s	Velocity Flow $V_2 = \frac{Q}{A_2}$ m /s	Measured head loss h_e (m of H_2O)	Remarks
1					
2					
3					
4					
5					
6					
7					

Table 2. Data for Determination of Static Pressure

No. of Obs.	Manometer Reading			Measured Pressure (m of H_2O)	Remarks
	Left Column (mm)	Right Column (mm)	Net Deflection (m)		
1					
2					
3					
4					
5					

Discussions:

Make a discussion on the experiment and the results obtained, such as, why does the determined results differ from the estimate results?

Conclusions:

APPENDIX

Moody diagram

(From L.F. Moody, *Trans. ASME*, Vol. 66, 1944)

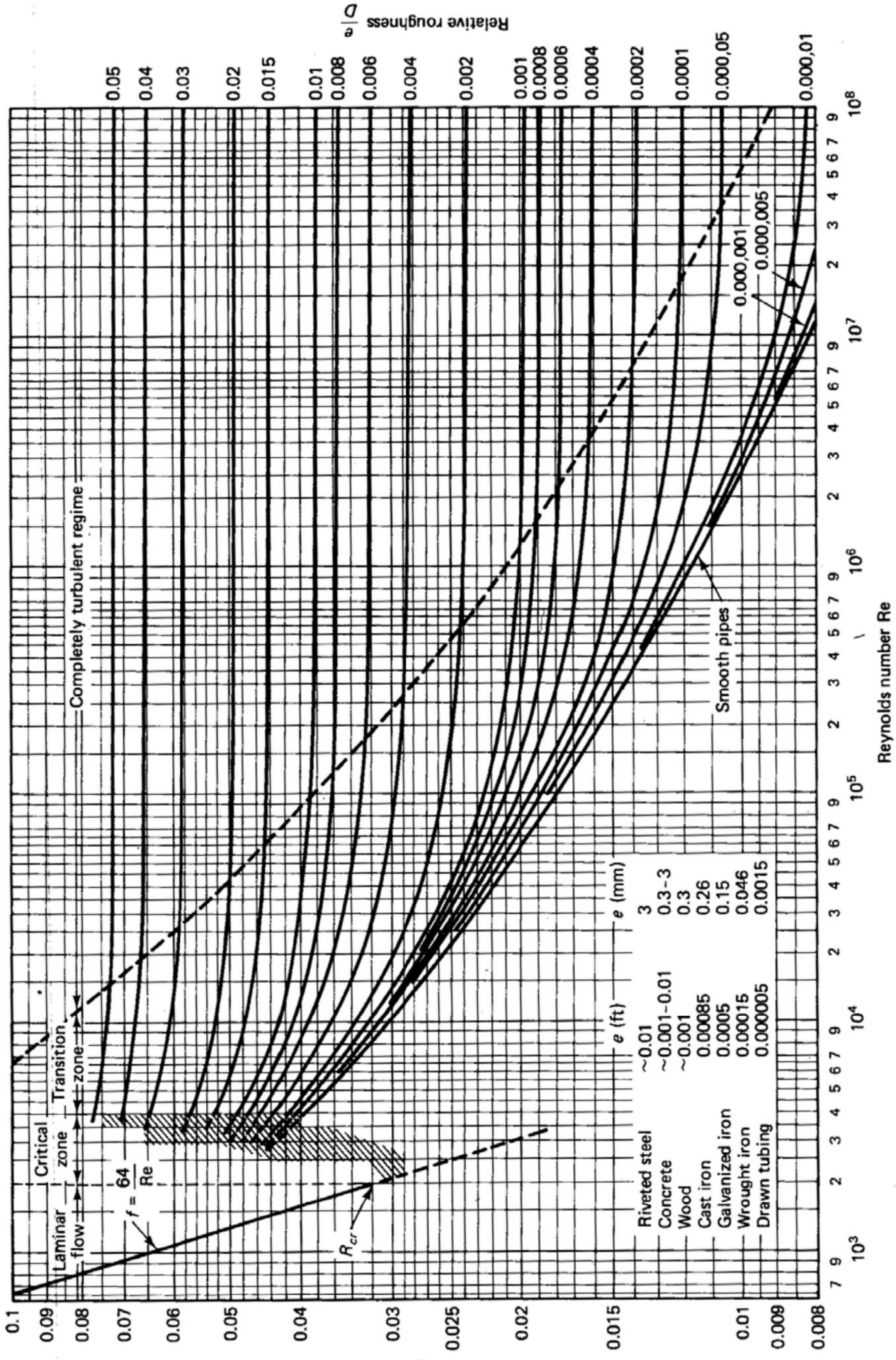
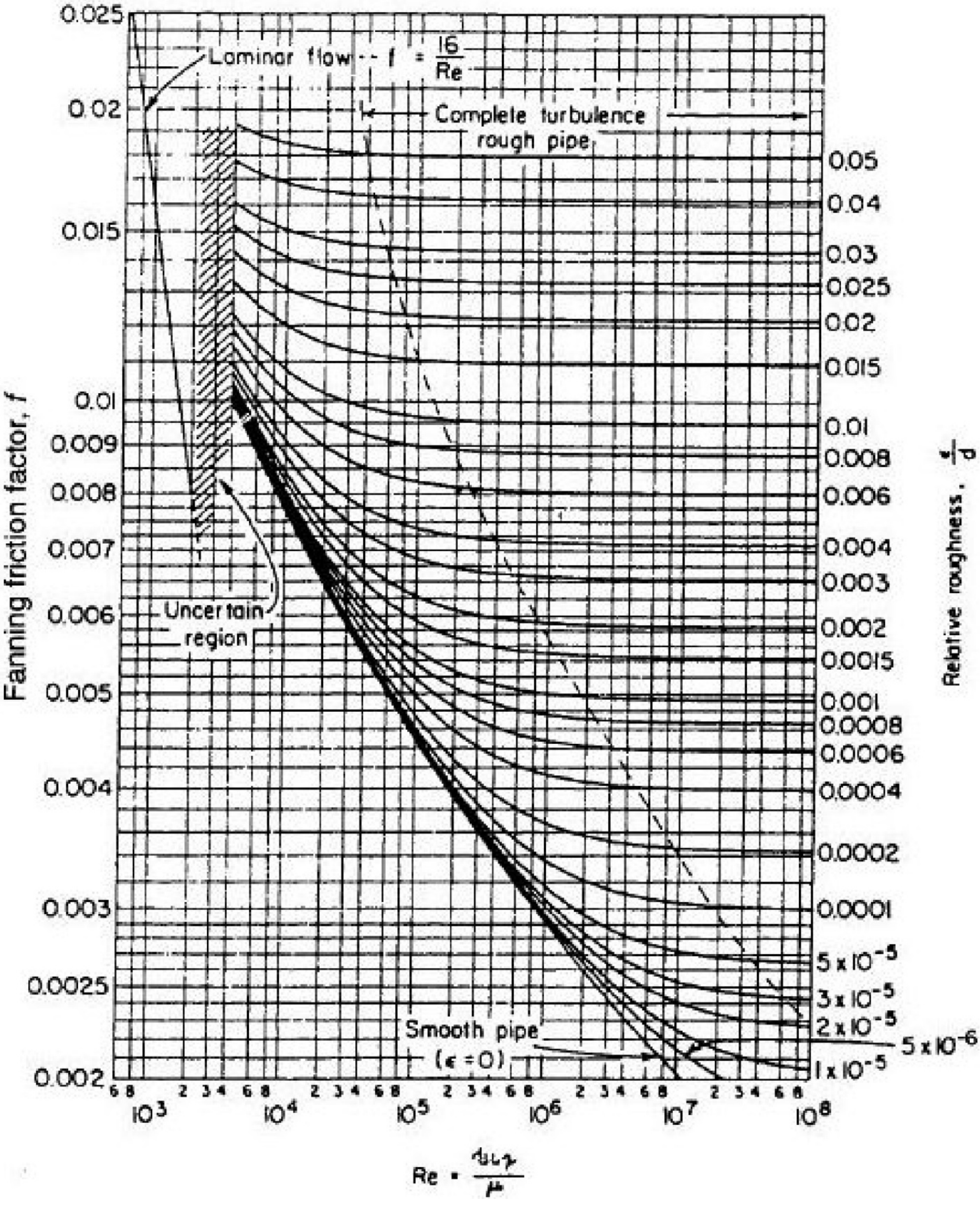


Diagram for Fanning Friction Factor

(From Wikipedia)



References:

[1] Minor head losses in pipe flow /www.hkdivedi.com
[2] Looses Due to Pipe Fittings, Sudden Enlargement & Contraction/http://www.goelscientificinstruments.com
[3] Moody diagram **(** From L.F. Moody, *Trans. ASME*, Vol. 66, 1944)
[4] Diagram for Fanning Friction Factor (From Wikipedia)

Technology	Mechanical
Model Subject	Hydraulics & Hydraulic Machineries
Semester	5th Semester
Subject Code	67051

Calibration of a Bourdon Tube Pressure Gauge

Mechanical Technology (Green Team)

Md. Aman Ullah Khan Eusufzi, Instructor, DPI

Md. Kamal Uddin Farazi, Instructor, DPI

Nazmul Haque Bakhtiar, Instructor, DPI

Md. Bodiuzzaman, Lecturer, TTTC

March 2022

Calibration of a Bourdon Tube Pressure Gauge

1. Objective

1) To calibrate a Bourdon tube pressure gauge.
2) To estimate the errors.

2. Theory

Instrument calibration is one of the primary processes used to maintain instrument accuracy. It is the process of configuring an instrument to provide results within an acceptable range. Known weights have been applied on a Dead Weight Calibrator to apply pressure to a fluid for checking the accuracy of readings from a pressure. Various types of pressure measuring instrument have been used to measure the pressure intensity at any point in static or moving fluid. One of these devices is the Bourdon tube pressure gauge. At present bourdon tube pressure gauges are most widely used because of their reliability, compactness, low cost and ease of use. It consists of a curved tube (Figure 1) of elliptical cross-section bent into a circular arc.

2.1 Bourdon Tube Gauge:

The Bourdon Gauge (Figure 1) is fitted with a transparent dial, which lets the internal workings of the gauge. The gauge consists of a thin walled closed ended tube which is oval in cross section. This tube is bent through an angle of about 270° angle along its long axis. The open end of the tube is welded to a hollow mounting block which allows the pressurized fluid to reach the tube. This causes the pressure from the source to be transmitted directly to the inside of the bourdon tube. The applied pressure causes the oval tube to become rounder (since around cross section has the maximum area for a given circumference). As it becomes rounder, the bourdon tube tends to uncurl which causes its free end to move. A system of linkages and levers transmits this motion to the gauge needle which moves over the scale. When pressure is applied to the tube, it tends to straighten out, and the deflection of the end of the tube is communicated through a system of levers to a recording pointer.

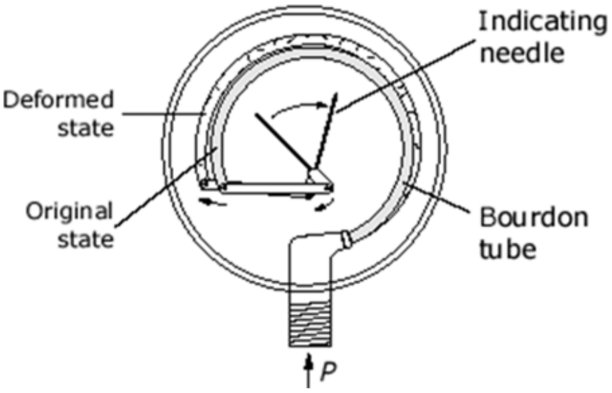


Figure 1: Bourdon Tube Gauge [1]

2.2 Dead Weight Calibrator:

In order to obtain very accurate pressure measurements, it is essential to regularly re-calibrate the gauge. This is because the tube tends to become weaker with extended use. The usual procedure is to apply a known pressure to the gauge using a device called a Dead Weight Calibrator. The normal calibration procedure is to load the gauge for known pressures, using a dead weight calibrator including a liquid of known specific gravity (use water as the liquid). This dead weight tester uses a simple piston and cylinder arrangement to provide a source of pressurized liquid (in the experiment water will produced a better result than oil) which is transmitted to the gauge. Since the true pressure of the liquid can be easily calculated, the value can be compared directly to the reading on the gauge over the complete scale range. The scale range is the range of pressures from zero to the full-scale deflection value. The dead weight tester consists of a cylindrical piston which is free to move vertically in a close fitting cylinder.

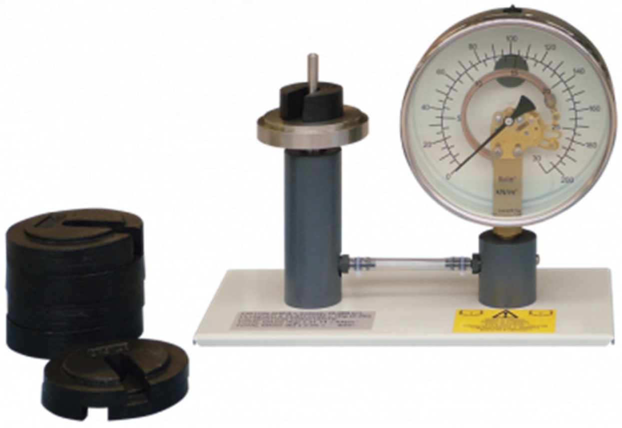


Figure 2: Dead Weight Calibrator with Bourdon Tube Gauge [2]

2.3 Governing Equations:

The use of the piston and weights with the cylinder generates a measurable reference pressure:

$$P=\frac{F}{A}=\frac{Mg}{A}$$

Where,

F = Force applied to the liquid in the calibrator cylinder in Newton (N).
M = Total mass including the mass of the piston in kilogram (kg).
A = Cross-sectional area of the piston in square meter (m^2).
g = Acceleration due to gravity in meter per square second (m/s).

- Diameter of piston=315 mm^2
- Weight of piston=1000 gm

3. Experimental Method

3.1 Experimental Apparatus:

1. Piston and cylinder arrangement
2. A liquid of known specific gravity
3. Transparent pipe
4. Set of test weights
5. Bourdon tube pressure gauge

3.2 Experimental Procedure:

1. Remove the piston and record its mass (M).
2. Measure the diameter of the cylinder and calculate the cross sectional area (A).
3. Fill the cylinder with water, to above the overflow pipe, ensuring that the air is expelled from the pipe.
4. Place the piston in the cylinder, allow it to settle and then record the gauge reading.
5. Continue loading the piston until a maximum of load is carried.
6. Remove the load on the piston in stages, recording the mass on the piston and the gauge reading in each stage.
7. All recording data input a table and calculate piston pressure.
8. Increase the load on the piston, by adding the weights in increments, record the gauge reading and mass on the piston at each increment.
9. Take the similar sets of readings with decreasing weights.

4. Result

4.1 Table of Observations and Calculations

Mass added to piston (kg)	Total mass on piston (kg)	Piston Pressure (Applied) KN/m^2	Gauge Reading			Average Error (%)
			Increasing KN/m^2	Decreasing KN/m^2	Average Gauge Pressure KN/m^2	
1	1	31.14				

Plot the following graphs:

1) Measured Gauge Pressure vs Applied Pressure

2) Average Error (vertical axis) vs Applied Pressure

5. Discussion

Make a discussion on the experiment and the results obtained, such as, why does the determined results differ from the estimate results?

References:

[1] Introduction to Bourdon Tubes, www.efunda.com
[2] Calibration of a Bourdon Pressure Gauge, www.tecquipment.com

Technology	Mechanical
Model Subject	Hydraulics & Hydraulic Machineries
Semester	5th Semester
Subject Code	67051

Determine Cc , Cv and Cd by Orifice Apparatus Equipped with Hydraulic Test Bench

Mechanical Technology (Red Team)

Md. Anwarul Hoque, Instructor, DPI
Md. Siddiqur Rahman, Workshop Super, DPI

March 2022

Title: Determine Cc , Cv and Cd by orifice apparatus equipped with hydraulic test bench.

1. OBJECTIVES:

The main objective of this experiment is to investigate/find out the C_c , C_v and C_d by circular/square/rectangular orifice apparatus.

On completion of the experiment, the participants will be able to

- Estimate the C_c , C_v and C_d.
- Understand the principle of static pressure measurement.

2. THEORY:

- **Orifice :** An orifice is an opening in a vessel through which water flows out, in case of orifice the upstream level of water is above the top edge of opening.
- **Vena Contracta :** It is the smallest area of water jet at the orifice, as shown in Fig-1(a)
- **Co-efficient of contraction:** Co-efficient of contraction ($C_{c)}$ is the ratio of area of jet at vena contracta to the actual area of orifice and it can mathematically given by the following equation.

$$C_c = \frac{A_c}{A_o} = \frac{C_d}{C_v}$$

- **Co-efficient of velocity :** Co-efficient of velocity (C_v) is the ratio of actual velocity to the theoretical velocity of jet from orifice and it can mathematically given by the following equation,

$$C_v = \frac{x}{2\sqrt{yH}}$$

- **Co-efficient of discharge :** Co-efficient of discharge is the ratio of actual discharge to theoretical discharge and it can mathematically given by the following equation.

$$C_d = \frac{Q_{actual}}{Q_{otheoritical}} = \frac{Volume/time}{A_o\sqrt{2gH}}$$

Reservoir with sharp edge orifice

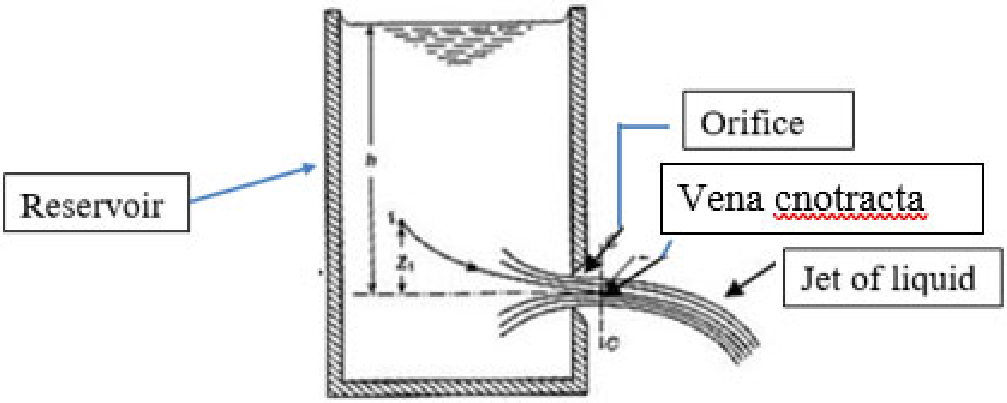


Fig-1(a)

- Area of Orifice = Ao
- Area of Vena Contracta = A_c
- Co-efficient of contraction, $C_c = \frac{A_c}{A_o}$
- Co-efficient of velocity, $C_v = \frac{x}{2\sqrt{yH}}$
- Co-efficient of discharge, $C_d = \frac{Q_{actual}}{Q_{otheoritical}} = \frac{Volume/time}{A_o\sqrt{2gH}}$

Vena contracta is the portion of jet with least diameter.

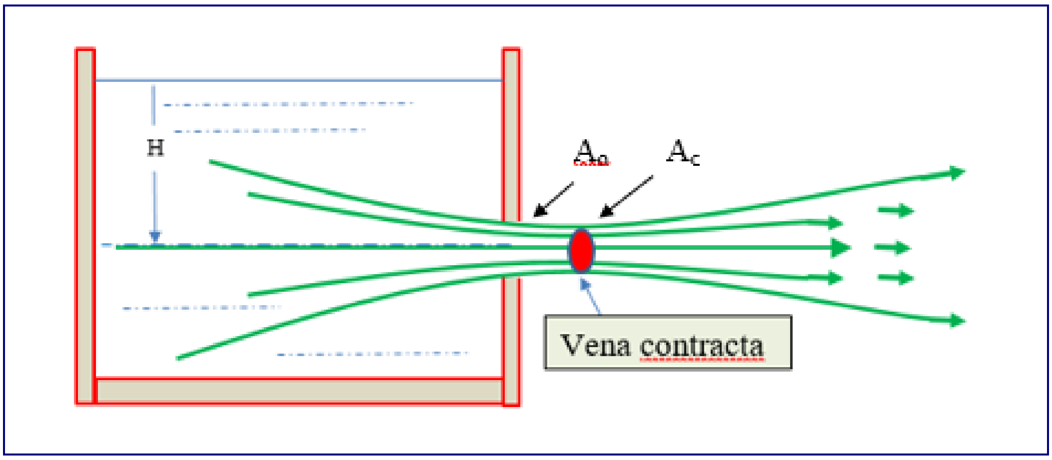


Fig-1(b)

- Diameter of orifice used in experiment is --------------- mm

Labeled diagram of Orifice and Jet Apparatus

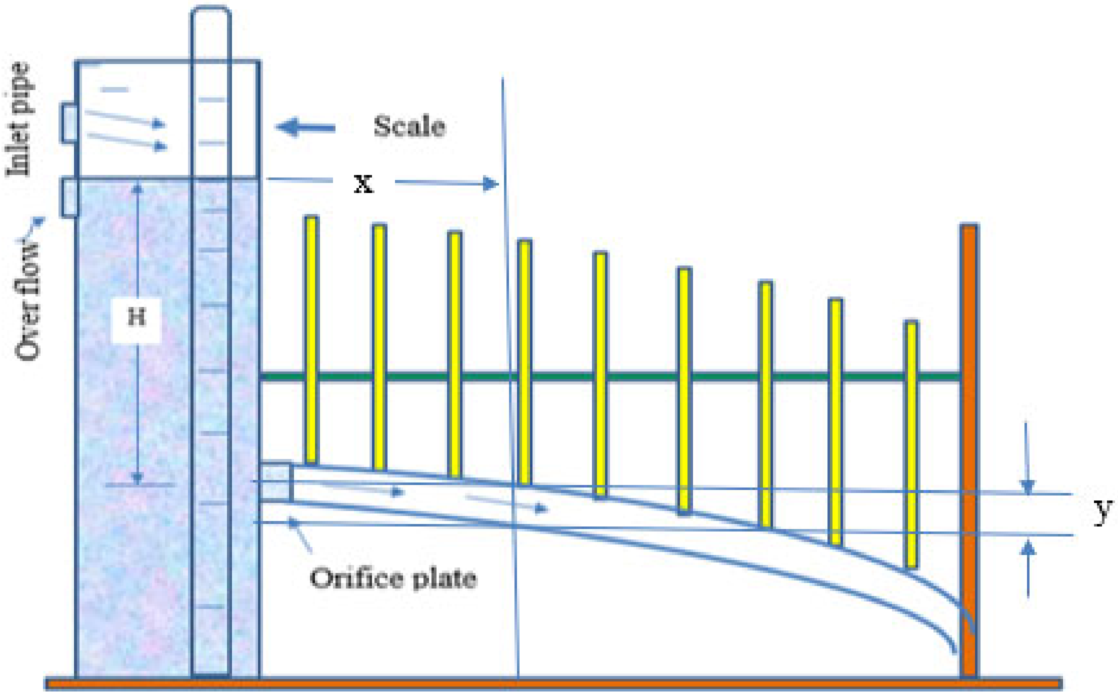


Fig-2

3. EXPERIMENT METHOD:

3.1. Experiment Apparatus

1. One plastic Jar
2. One Plastic Box
3. One Beaker with scale
4. A small aquarium pump
5. PVC pipe (16x2M)
6. Rubber hose pipe (clear, 12x16x2M)
7. Silicone sealant with gun Safety 3 Elbow for Main Hose (12mm) – 2 Nos.
8. Silicone Tube, 4mm x 6mm, 2M
9. Joint Two-Way Hose Fitting (4 mm) – 2 Nos.
10. Clear Rigid Acrylic Pipe 4mm
11. Soldering Iron
12. Steel ruler and stopwatch
13. Sealing Tape
14. Gate Valve – 1 no.

3.2 . Experiment Procedure

1. Set the apparatus
2. Adjust the orifice and jet apparatus over the reserve water tank
3. Start the pump and maintain a water head (h_o) in the jar with the help of control valve.
4. Water will come out the orifice. Screw up the needles according to the path of the water jet.
5. Mark the points of top of needles accurately by pencil on graph paper.
6. For actual discharge measure the head of water in the measuring tank and keep the time needed by stopwatch.
7. Remove the paper and find x and y distances with respect to a reference line.
8. Plot y on x-axis and x^2 on y-axis in Excel and calculate slope for calculating C_v.

4. RESULT

4.1 OBSERVATIONS AND CALCULATIONS:

1. After completing the experiment documented x, y and x^2 given in the following table. A sample table can be used like this.

No	x(cm)	y(cm)	x^2(cm^2)
1			
2			
3			
4			
5			
6			
7			
8			

2. After plotting y and x2 Values we can obtain a graph as follows.

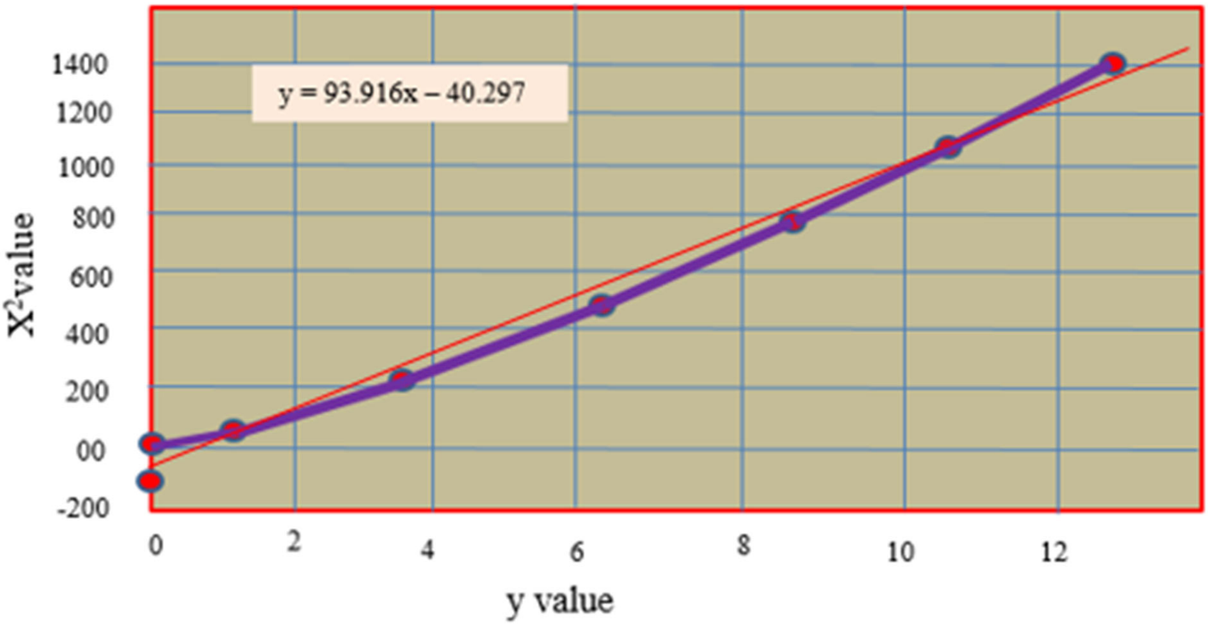


Fig-3

4.2 Calculations:

we get $\frac{x^2}{y} = - - - - - -cm\ and\ we\ have,$ h$_o$ = ----------- cm

C$_v$ = $\frac{x}{2\sqrt{yH}}$ = -----------------

For C_d

C$_d$ = $\frac{Q_{actual}}{Q_{otheoritical}} = \frac{Volume/time}{A_O\sqrt{2gh_O}}$

From Experiment:

Diameter of orifice, D = -------- cm,

Area of orifice, A$_o$ = --------- cm^2

Take g = 980 cm/sec^2

Volume V = -------- cm^3

Hight of water H = -------- cm

Time t = ------- sec

Theoretical discharge, Q$_{th}$ = A$\sqrt{2gh}$ cm^3 = -----------

Actual Discharge, Q$_{ac}$ = V/t cm^3 = -----------

C$_d$ = $\frac{Q_{actual}}{Q_{otheoritical}}$

C$_d$ = ---------

Now to calculate Cc

C$_c$ = $\frac{A_c}{A_O} = \frac{C_d}{C_v}$

C$_c$ = --------

(1) Plot experimentally obtained C$_c$, C$_v$ & C$_d$.
(2) Compare the results with the theoretical results

5. Discussion:

Make a discussion on the results obtained. For example, why does the analytical results differ from the estimated results.

References

1. R.S Khurmi, Hydraulics and Hydraulic Machineries, S. Chand & Company Ltd.
   Ram Nagar, New Delhi-110055, 1970 --- 2007.
2. https://en.wikipedia.org/wiki/Vena_contracta

Technology	Mechanical
Model Subject	Hydraulics & Hydraulic Machineries
Semester	5th Semester
Subject Code	67051

Analysis of Impact of Jet on a Flat Vane and Hemispherical Vane

Mechanical Technology (Yellow Team)

Jannatul Ferdousy, Specialist (Research), BTEB
Siam Sarwar, Lecturer, TTTC
Hafiz Al Ashad, Junior Instructor, DPI

March 2022

Analysis of impact of jet on a flat vane and hemispherical vane

Objectives:

1. To compare the theoretical and experimentally measured force exerted on a flat vane.
2. To compare the theoretical and experimentally measured force exerted on a hemispherical vane.

Theory:

Jet is a rapid stream of liquid or gas forced out of a small opening. It can also be defined as a stream of continuum fluid that is projected into a surrounding medium, usually from some kind of a nozzle, aperture or orifice. Jets can travel long distances without dissipating. Water jet may refer to a jet of water under pressure, like in an ornamental fountain.

Impact of jet means the force exerted by the jet on the plate which may be stationary or moving. Impact of jets apparatus enables experiments to be carried out on the reaction force produced on vanes when a jet of water impacts on to the vane. The study of these reaction forces is an essential step in mechanics of fluids which can be applied to hydraulic machinery such as the Pelton wheel and the impulse turbine.

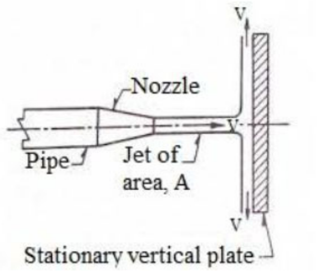


Fig. 1: Jet striking on a stationary plane [1]

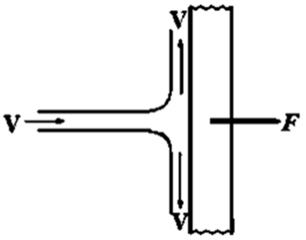


Fig. 2: Impact force, F

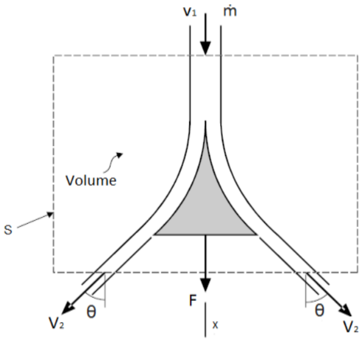


Fig. 3: Sketch of jet impinging on a vane

Applying Newton's second law in the direction of the incident jet,

Force = Mass × Acceleration

F = Mass Flow rate × Change in Velocity

$F = \dot{m}\ (v_1 - v_2)$

$F = \rho\ Q\ (v_1 - v_2)$

Here,

F = Impact Force [N]

ρ = Density of water [kg/m^3]

Q = Flow rate [L/s]

v_2 = Exit Velocity [m/s]

v_1 = Impact Velocity [m/s]

For jet,

$v_1 = v$

$v_2 = v \cos \theta$

Therefore, impact force can be given by the following equation.

$F = \rho\ Q\ v\ (1 - \cos \theta)$

Here, θ is the outlet angle of the jet, which varies with different geometrical shapes of the target vanes.

The jet velocity can be calculated from the measured flow rate and the nozzle exit area.

$Q = Av$

$v = Q/A = Q/(\pi \mathrm{d}^2/4)$

Here,

d = Nozzle Diameter [m]

A = Area [m^2]

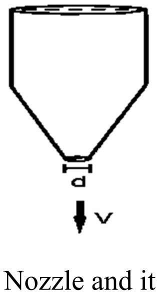


Fig. 4: A Nozzle and its Diameter

Error Analysis

The percentage of error for this setup can be determined from the calculated values of the reaction forces and the experimentally measured reaction forces. It can be calculated from the given formula:

$$\text{Percentage of Error} = \frac{\text{Theoretical Value} - \text{Experimental Value}}{\text{Theroretical Value}} \times 100\%$$

Experiment Method:

Apparatus:

1. UPVC pipe (12mm)
2. Thread Tape
3. Adhesive/glue
4. Sealant
5. Flexible pipe (19mm)
6. Clamp (19mm)
7. Clamp (12mm)
8. PVC Gate valve (19mm)
9. Laboratory Stand with Clamp
10. Water Tank
11. Ping pong ball
12. Cutting Knife
13. Hacksaw frame
14. Digital weight machine (water proof)- Laboratory standard
15. Thin Transparent Acrylic board
16. Fine needle
17. Graduated Beaker- 500 ml
18. Sealant gun
19. 60 Volt Submersible pump with fittings
20. Hacksaw blade
21. Thin Aluminum Sheet 18"/20"
22. PVC Elbow
23. PVC Socket
24. CPVC Elbow
25. CPBC Socket
26. Regulator
27. CPVC pipe
28. Teflon Round Bar
29. Regulator block
30. Emery paper

Setup:

A pipe of 12mm diameter will be connected with the pipe of 6mm diameter. The 6mm diameter of pipe will work as the nozzle. The 12mm diameter of pipe will be connected with 19mm diameter of pipe using the clamp to get connected with the 12V pump. An Acrylic board will be placed on the weight machine and an impact vane will be placed on the board near the nozzle. The whole setup will be placed on a water tank.

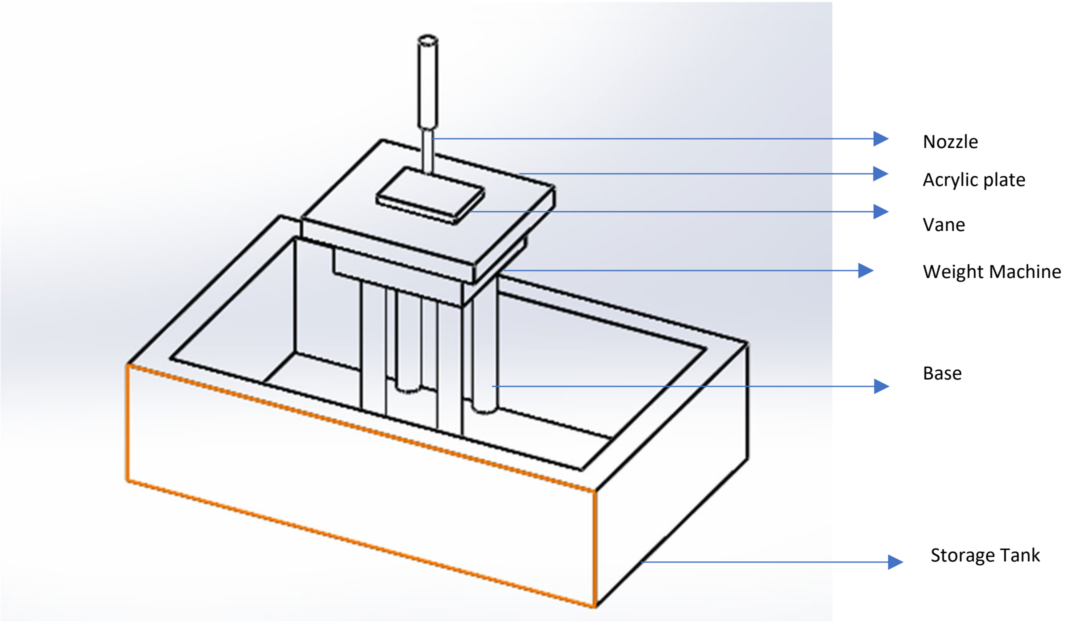


Fig. 5 3D view of the experimental setup

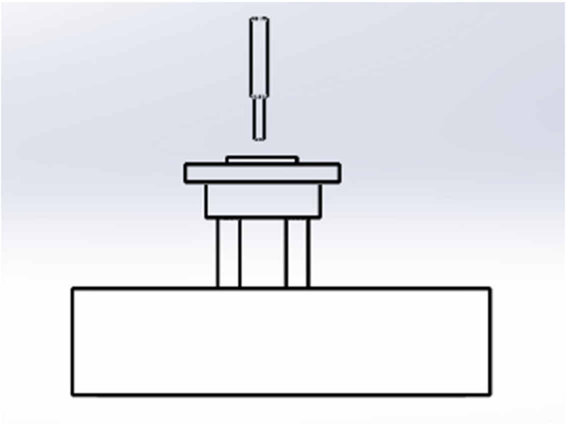


Fig.6 Front view of the experimental setup

Procedure:

1. Measure the flowrate using graduated beaker and stop watch.
2. Take the initial reading of the weight machine.
3. Turn on the pump. Jet will create impact on the vane which will transfer to the weight machine. Take the reading. Subtract this reading from previous reading to get the extracted force in kg.
4. Repeat this for different flowrate and different vane

Results:

Flat Vane (*θ=90°)*

Sl. no.	Water discharge (L)	Time (s)	Flow rate (m^3/s)	Velocity (m/s)	Force in (g)	Force [N]		% of error
						Theoretical	Experimental	

Hemispherical Vane (*θ=180°)*

Sl. no.	Water discharge (L)	Time (s)	Flow rate (m^3/s)	Velocity (m/s)	Force in (g)	Force [N]		% of error
						Theoretical	Experimental	

Performance characteristics curves which to be discussed are,

1. Flow rate vs. Theoretical force
2. Flow rate vs. Experimental force
3. Flow rate vs. Percentage of error

Discussion:

Prepare discussion addressing the following issues:

A) Why did theoretical and experimental results differ?
B) How errors could be minimized?
C) What decisions could be made from the performance characteristic curves?

References:

M. Q. Islam, “Hydraulic Machines”, ISBN 984-07-3279-X, Published by Bangla Academy, Dhaka, Bangladesh, June 1995.

https://www.scribd.com/doc/51634941/Impact-Of-A-Jet-Lab-Report

http://www.eng.ucy.ac.cy/EFM/Manual/HM%2015008/HM15008E-ln.pdf

https://www.scribd.com/doc/48248022/Impact-of-a-Jet-of-Water

Computer Technology

Technology	Computer
Model Subject	Programming in Java
Semester	5th Semester
Subject Code	66651

Write and Execute Java Programs Using Arrays and Control Flow Statements

Computer Technology (Blue Team)

Mohammad Sajedul Islam, Chief Instructor, BPI

Modina Akhter, Chief Instructor, DTE

Sayema Aktar, Junior Instructor, DMPI

March 2022

Title: Write and execute java programs using arrays and control flow statements.

1. Objective:

Declaration and Data processing of array.

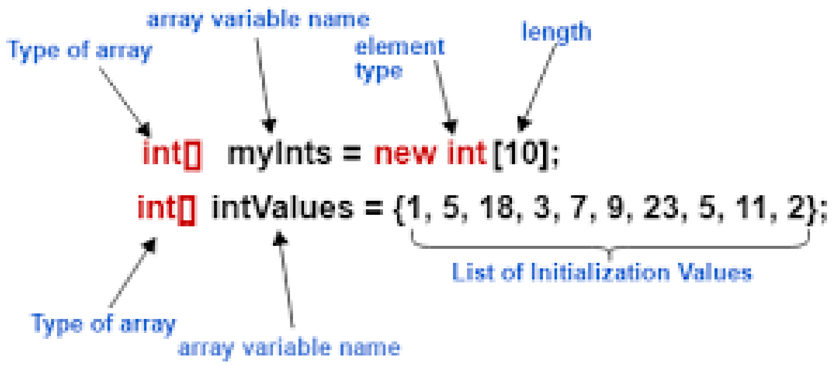
2. Theory:

An array stores a sequence of values that are all of the same data type.

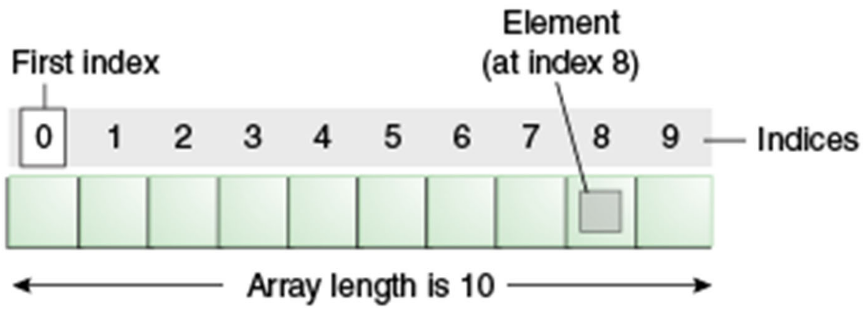
To declare an array, define the variable type with **square brackets**

Syntax of array is

data type array_ name = new data type[size]



```
int[] myInts = new int[10];
int[] intValues = {1, 5, 18, 3, 7, 9, 23, 5, 11, 2};
```



3. Experiment method:

a) Experiment Apparatus:

1. Computer system.
2. Software.

   Using software: Java var.8

   Development environment: Apache NetBeans 12.6

3. Hands-on manual.

b) Experiment Procedures:

I. Run the computer system
II. Open java software
III. Create new project
IV. Coding the given example program

Write a java program to print the sum of all the items of the array.

```
 public class SumOfArray {
public static void main(String[] args) {
  //Initialize array
  int [] arr = new int [] {1, 2, 3, 4, 5};
  int sum = 0;
  //Loop through the array to calculate sum of elements
  for (int i = 0; i < arr.length; i++) {
    sum = sum + arr[i];
  }
  System.out.println("Sum of all the elements of an array: " + sum);
 }
}
```

4. Discussion:

When we are declaring an array, array size may be different. According to array size, we will insert elements and result will be depends on number of elements.

What happens if you refer to a variable that has not been assigned a value?

What happens if you declare an array, create the array, and then reference the values of the elements without ever assigning a value to each element?

5. Exercise:

What is the summation of array when array elements are 1 to 10 .

6. Reference:

https://www.javatpoint.com

https://www.w3schools.com

```
Sum of all the elements of an array: 1
```

Technology	Computer
Model Subject	Programming Essentials
Semester	3rd Semester
Subject Code	66631

Information Sheet of Loop Structures

Computer Technology (Green Team)

Sujit Bikash Chakma, Instructor, TTTC

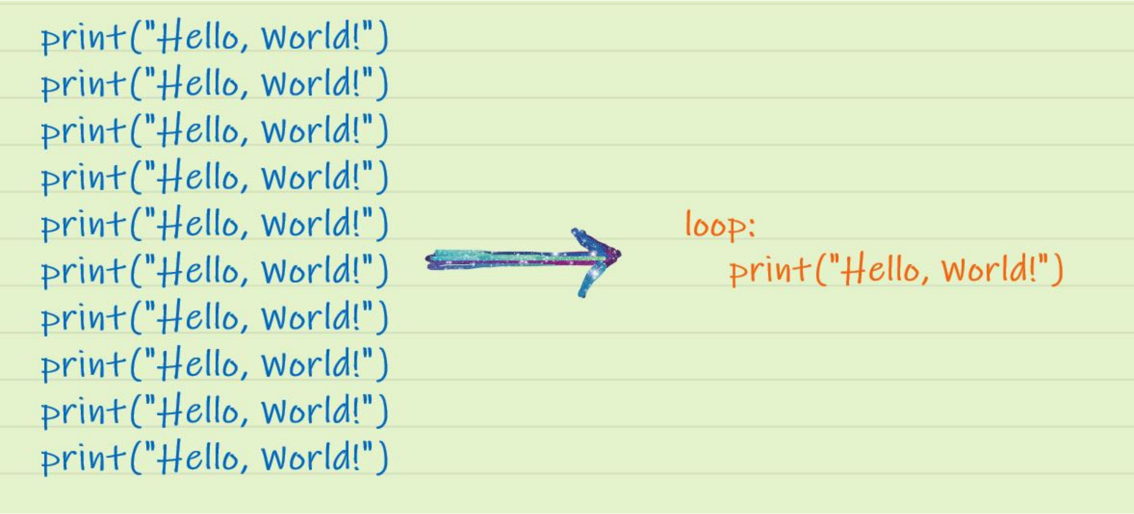
Lutfa Khanom, Junior Instructor, DPI

Afroja Begum, Junior Instructor, DMPI

March 2022

Information Sheet of Loop Structures

Background: In computer programming, a ***loop*** is a sequence of instructions that is ***repeated*** until a ***certain condition*** is reached. Loops help us to remove the redundancy of code when a task has to be repeated several times. With the use of loops, we can cut short those hundred lines of code to a few. Whenever a programmer needs to execute a statement or block of statements ***repeatedly*** then he has to use ***loop*** in the program. Suppose you want to print the text "Hello, World!" 10 times. Rather than writing a print statement 10 times, you can make use of loops by indicating the number of repetitions needed.



```
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
print("Hello, World!")
```

```
loop:
    print("Hello, World!")
```

Sl. No	Loop Type & Description
1	while loop Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
2	for loop Execute a sequence of statements multiple times and abbreviates the code that manages the loop variable.
3	do...while loop Like a 'while' statement, except that it tests the condition at the end of the loop body.
4	nested loops You can use one or more loop inside any another 'while', 'for' or 'do..while' loop.

Objectives: The objective is to equip a student with the necessary knowledge so as to be able to the following things upon completion of the lesson.

1. To define and understand the ***syntax*** of different types of loop.
2. To draw ***flow*** chart of the loop
3. To ***implement*** different loop in the programs.

Implementation methodology of *for* loop:

Syntax:

for val in sequence:
loop body

Explanation: Here, val is the variable that takes the value of the item inside the sequence on each iteration.

Loop continues until we reach the last item in the sequence. The body of for loop is separated from the rest of the code using indentation.

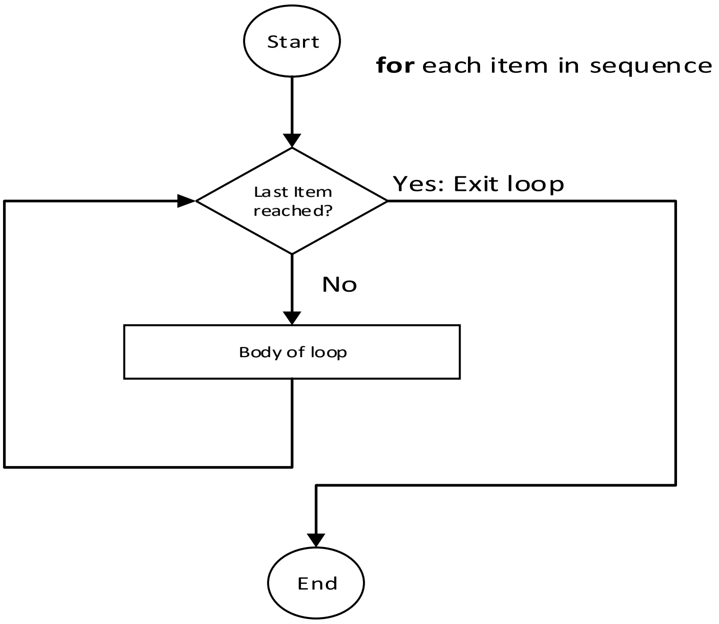


Figure 1 For loop flow chart

Range Function:

To loop through a set of code a specified number of times, we can use the range() function. The range() function returns a sequence of numbers, starting from 0 by default, and increments by 1 (by default), and ends at a specified number.

Syntax of Range Function:

range*(start, stop, step*)

start: from what value the loop will start

stop: from what value the loop will continue

step: increment after each iteration

Implementation methodology of *While* Loop:

Syntax:

while test expression:
Body of while

Explanation: In the while loop, test expression is checked first. The body of the loop is entered only if the test expression evaluates to *True*. After one iteration, the test expression is checked again. This process continues until the test expression evaluates to *False*.

The body starts with indentation and the first unindented line marks the end.

Python interprets any non-zero value as True. None and 0 are interpreted as False.

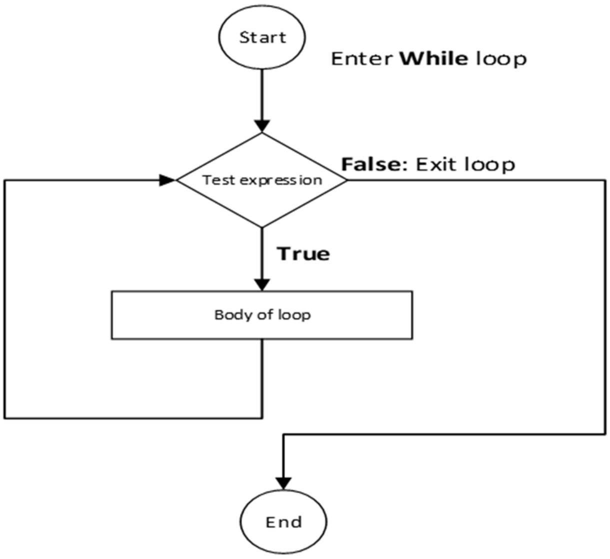


Figure 2 While loop flow diagram

Implementation methodology of *Nested* Loop:

A nested loop is a loop inside a loop. We can use any type of loop inside any type of loop such as a **while** loop inside **for** loop, a **for** loop inside a **while** loop, a **while** loop inside a **while** loop, or a **for** loop inside a **for** loop. The "inner loop" will be executed one time for each iteration of the "outer loop".

Required Systems and Software's:

1. A Computer System
2. Python software: PyCharm, Thonny etc.
3. Information Sheet/Job Sheet/Experimental Sheet

Experimental Sheet of ***for*** loop

Example 1: Program to print Prime Numbers from 1 to 100

```
 for Number in range (1, 101):
    count = 0
    for i in range(2, (Number//2 + 1)):
        if(Number % i == 0):
            count = count + 1
            break

    if (count == 0 and Number != 1):
        print(" %d" %Number, end = '  ')
```

Result (Sample):

```
2  3  5  7  11  13  17  19  23  29  31  37  41  43  47  53  59  61  67  71  73  79  83
89  97
```

Example 2: Program to find the sum of all numbers stored in a list

```
# List of numbers
numbers = [6, 5, 3, 8, 4, 2, 5, 4, 11]
# variable to store the sum
sum = 0
# iterate over the list
for val in numbers:
    sum = sum+val
print("The sum is", sum)
```

Result (Sample): The sum is 48

Example 3: Program to iterate through a list using indexing

```
genre = ['pop', 'rock', 'jazz']
# iterate over the list using index
for i in range(len(genre)):
```

```
    print("I like", genre[i])
```

Result (Sample):

```
I like pop
I like rock
I like jazz
```

Experimental Sheet of ***While*** loop

Example 1: Program to print Prime Numbers from 1 to 100

```
Number = 1
while(Number <= 100):
    count = 0
    i = 2

    while(i <= Number//2):
        if(Number % i == 0):
            count = count + 1
            break
        i = i + 1

    if (count == 0 and Number != 1):
        print(" %d" %Number, end = '  ')
    Number = Number  + 1
```

Result (Sample):

```
2   3   5   7   11   13   17   19   23   29   31   37   41   43   47   53   59   61   67   71   73   79   83
89   97
```

Example 2: Program to add natural numbers up to 1+2+3+...+n

```
# To take input from the user,
# n = int(input("Enter n: "))
n = 10
# initialize sum and counter
sum = 0
i = 1
while i <= n:
    sum = sum + i
    i = i+1    # update counter
# print the sum
print("The sum is", sum)
```

Result (Sample):

```
Enter n: 10
The sum is 55
```

Example 3: Print i as long as i is less than 6

```
i = 1
print("The numbers are: ")

while i < 6:
  print(i)
  i += 1
```

Result (Sample):

```
The numbers are:
1
2
3
4
5
```

Experimental Sheet of nested ***for*** loop

Example 1: Print each adjective for every fruit.

```
adj = ["red", "big", "tasty"]
fruits = ["apple", "banana", "cherry"]

for x in adj:
  for y in fruits:
    print(x, y)
```

Result (Sample):

```
red apple
red banana
red cherry
big apple
big banana
big cherry
tasty apple
tasty banana
tasty cherry
```

Example 2: Create a list of even numbers between 1 and 10

```
even_list = []
for item in range(1, 11):
    while item % 2 == 0:
        even_list.append(item)
        break
print("Even Numbers: ", even_list)
```

Result (Sample):

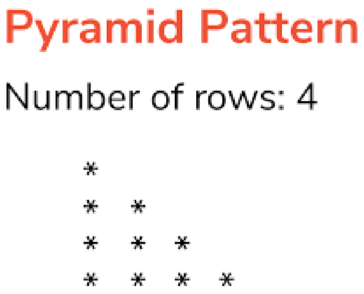
```
Even Numbers: [2, 4, 6, 8, 10]
```

Discussion

What would happen if there were no terminating conditions in a loops?

Related Problem

1. Take a variable from the Keyboard and calculate the prime number for the variable.
2. Calculate the summation of $1^2+2^2+3^2+$……….$+10^2$.
3. Write a program to display the pyramid-



Pyramid Pattern

Number of rows: 4

```
*
*  *
*  *  *
*  *  *  *
```

References:

1. W3 schools
2. Learning Python – Mark Lutz.
3. Website List: http:// python.howtocode.com.bd
4. http:// www.learnpython.org
5. http://pythontutor.com

Technology	Computer
Model Subject	Programming Essentials
Semester	3^{rd} Semester
Subject Code	66631

Prepare a Program Using User Define Function

Computer Technology (Red Team)

Zahed Ahmad Chowdhury, Chief Instructor, DPI

Mst. Shafinaz Khatun, Instructor, DMPI

Maksuda Yeasmin, Junior Instructor, DMPI

March 2022

Title: Prepare a program using user define function.

1. Objective:

After completing the job, students will be able to:

a) Identifying the difference between User define & Built-in function
b) Making/designing own user-defined function
c) Calling a User defined function from the main program

2. Theory:

2.1 Built-in Functions:

Functions that readily come with Python are called built-in functions. If we use functions written by others in the form of a library, they can be termed library functions. All the other functions that we write on our own fall under user-defined functions. So, our user-defined function could be a library function to someone else.

print(), input() and **int()** are some examples of a built-in function of Python.

2.2 User-defined functions:

- User-defined functions are that we define ourselves to do a certain specific task are referred to as user-defined functions.
- User-defined functions help to decompose a large program into small segments which make the program easy to understand, maintain and debug.
- If repeated code occurs in a program. A function can be used to include those codes and execute them when needed by calling that function.
- Programmers working on a large project can divide the workload by making different functions.

2.3 Structure of User Define Function:

```
def function_name(formal_arguments):
        Function statement-1
        Function statement-2
        . . . . . . . . . . . . . . . . . .
        Function statement-n
        return (agruments)
```

def: It is a function definition statement in the python program.

Function name: A function must follow the same rules of formation as other variable names in Python.

Arguments: It contains valid variables names separated by commas. The list must be surrounded by parenthesis.

return: This statement is for returning a value to the calling function. This is an optional statement. It's absence/return 0 indicates that no value is being returned to the calling function.

2.4 Function Calling:

Function_name(Actual_arguments)

2.5 A simple example of User Define Function:

```
# the use of user-defined functions
def add2 (x,y):
        sum = x + y
        return sum
num1 = 5
num2 = 6
print("The sum is", add2(num1, num2))
```

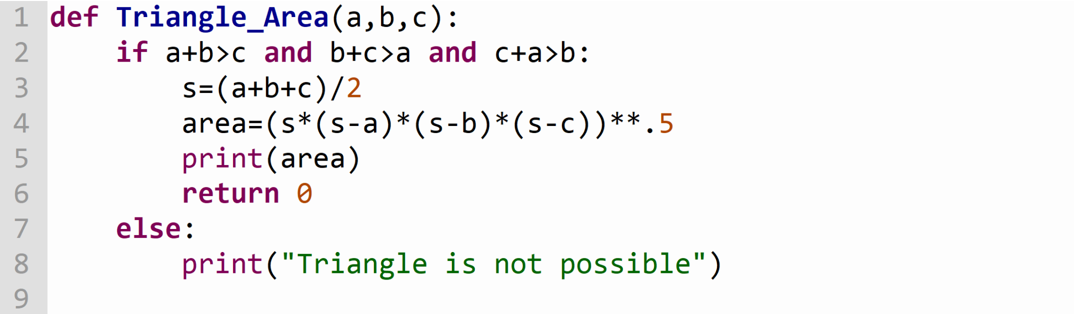
3. Experiment Method:

3.1 Experiment Apparatus:

i) Computer System
ii) Python Software (Thonny 3.3.13)
iii) Hands-on Manual

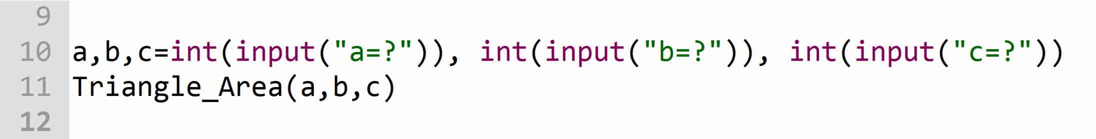
3.2 Experiment Procedure:

i) Start the Computer system
ii) Open a Python Software (Thonny environment version 3.3.12 or above)
iii) Coding the given example program below:
prepare a "user define function" to calculate the area of a Triangle.



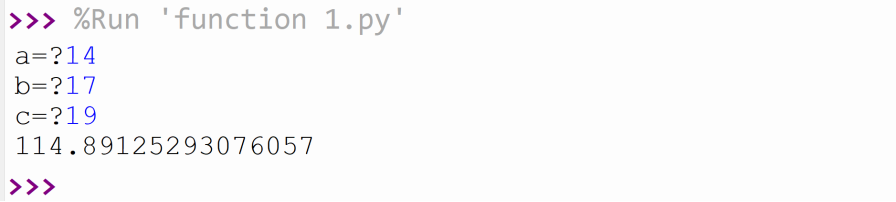
```
def Triangle_Area(a,b,c):
    if a+b>c and b+c>a and c+a>b:
        s=(a+b+c)/2
        area=(s*(s-a)*(s-b)*(s-c))**.5
        print(area)
        return 0
    else:
        print("Triangle is not possible")

```

iv) Code the main program

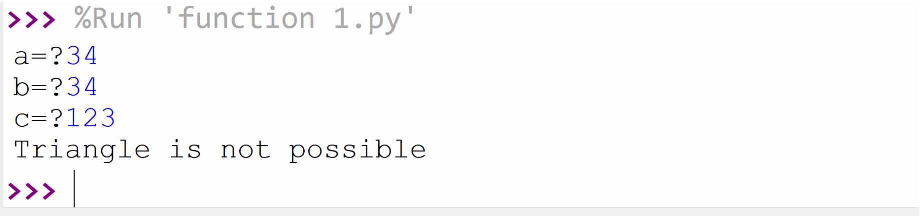


```

a,b,c=int(input("a=?")), int(input("b=?")), int(input("c=?"))
Triangle_Area(a,b,c)

```

v) Then Run the above coded program.
vi) Debug the program if necessary.
vii) Observed the outputs for given inputs below



```
>>> %Run 'function 1.py'
a=?14
b=?17
c=?19
114.89125293076057
>>>
```



```
>>> %Run 'function 1.py'
a=?34
b=?34
c=?123
Triangle is not possible
>>> 
```

4. Result:

Fill up the Table below with remarks according to the given input:

Sl No	Program Input	Program output	Remarks
1	a=8, b=8, c=8		
2	a=8, b=8, c=17		

5. Discussion:

According to the example program, lines 1 to 8 are user-defined functions and 10 and 11 are the main program. Here we call the main program into the function block which says the call by reference. A function can call into the main program that says the call by value. So, try to modify the program where function program will be called by value.

6. Exercise:

6.1 Try to prepare a program using a user-defined function for calculating the summation of even numbers between 20 to 50.

- where no actual and formal argument(s) are used.
- write your comments after completion.

6.2 Try to prepare a program for determining the smallest value from three integer numbers

- where arguments will be used
- and return the result from function to main part then print.
- write your observation.

Reference:

For Python Built-in Function: https://pythonexamples.org/python-list-of-functions/
For User define function: https://www.geeksforgeeks.org/python-user-defined-functions/

Technology	Computer
Model Subject	Programming Essentials
Semester	3rd Semester
Subject Code	66631

Writing a Program by Using Arithmetic Operators in Python

Computer Technology (Yellow Team)

Md Khorshed Alam, Chief Instructor, HOD, DMPI
Nigar Sultana, Chief Instructor, Graphic Arts Institute
Rezauna Khandaker Maya, Junior Instructor, DMPI

March 2022

Title: Writing a program by using Arithmetic Operators in Python.

1. Objectives

Understand and be able to program the following:

a) Identifying the different type of Operators used in Python
b) Identifying the Arithmetic Operators
c) Writing and executing the Program

2. Theory

Operator: In Python, an operator is **a symbol or symbols that determine the action that is to be performed or considered**.

- **Python language supports the following types of operators.**

- Arithmetic Operators.
- Comparison (Relational) Operators.
- Assignment Operators.
- Logical Operators.
- Bitwise Operators.
- Membership Operators.
- Identity Operators.

Arithmetic operators are used to perform mathematical operations like addition, subtraction, multiplication, and division.

There are 7 arithmetic operators in Python :

1.	Addition	+
2.	Subtraction	-
3.	Multiplication	*
4.	Division	/
5.	Modulus	%
6.	Exponentiation	**
7.	Floor division	//

3. Experiment Method:

a) Experiment Apparatus:
i) Computer System
ii) Using software : Python 3.7.7, Development environment : Thonny 3.3.13
iii) Job/Experiment Sheet/Hands on Manual

b) Experiment Procedure:
i) Run the Computer system
ii) Open a Python Software
iii) Open a python editor
iv) Coding the given example program

write a program using arithmetic operators:

```
x = 9
y = 4
print('x + y =',x+y)

print('x - y =',x-y)

print('x * y =',x*y)

print('x / y =',x/y)

print('x // y =',x//y)

print('x ** y =',x**y)

print('x % y =',x%y)
```

v) Run the program.
vi) Debug the program if necessary.
vii) See the output.

4. Result:

Fill up the Table below with remarks according to the given input:

(Please insert the table)

Sl No	Program input	Program output	Remarks
1	x=9,y=4		
2	X=6,y=4		

5. Discussion:

1. Investigate the precedence of operators.
2. What is the order in which calculations are processed when adding and multiplying are mixed?

6. Exercises:

Assign 5 to the variable a, 3 to the variable b, and find the remainder when a is divided by b.

Reference:

https://www.w3schools.com

Appendix 1-5: Guideline for improving technical education

Guideline for preparing hands-on manuals on experiments and practical training

1. Designing a training

The following factors should be discussed when designing a training. The basic stance on training design is to set a goal and develop a method based on that goal.

A) Goal	Where am I going?
B) Evaluation method	How do I know when I get there? How do I know if I have achieved the goal? Visualization of goals
C) Training planning	How do I get there?

2. How to set goals

It is necessary to make **what students can do** observable. For this purpose, it is advisable to use **action verbs** in setting **goals** with students as the subject to describe what they will be able to do through the training.

Express the goal in observable actions, not in conceptual terms such as *understand*.

For example:

[Knowledge]

enumerate, describe in detail, explain, classify, predict, relate

[Attitude]

carry out, inquire, help, indicate, represent, express, communicate

[Skills]

feel, imitate, devise, be proficient, implement, operate, measure, prepare, activate

3. Achievement level in experiments and practical trainings and the development of hands-on manuals based on the level

A hands-on manual on experiments and practical trainings should be prepared for every level in the rubric of achievement levels shown in Figure 1.

Achievement Level	Level 1	Level 2	Level 3	Level 4
Subject	Experiments and practical training		Project-Based Learning (PBL)	
Planning and implementation	Be able to conduct experiments based on pre-designed procedures with advice from the instructor.	Be able to conduct experiments by him/herself based on the prepared procedures.	Be able to conduct basic experiments on his/her own.	Be able to conduct experiments based on the experiments needed for problem solving.
Preparation and operation of equipment and instruments	Be able to properly use the laboratory equipment and instruments as instructed with the support of the instructor.	Be able to properly use the laboratory equipment and instruments as instructed according to the operation manual.	Be able to prepare the necessary laboratory equipment and instruments and perform basic operations.	Be able to select and operate laboratory equipment and instruments correctly according to their functions and range of application.
Results, analysis, and discussion	Be able to summarize, analyze, and discuss results in a pre-designed format.	Be able to summarize, analyze, and discuss results according to instructions.	Be able to follow instructions, summarize results, and analyze and reflect on results independently.	Be able to logically analyze and discuss the obtained results.

Figure 1: A Rubric of achievement levels for experiments and practical trainings

○ Preparing a Manual for Achievement Level 1 (LV1）

Planning and implementation

Be able to conduct experiments based on the prepared procedures with the advice of the instructor and others

Preparation and operation of equipment and instruments

Be able to properly use laboratory equipment and instruments as instructed with the support of the instructor and TA

Results, analysis, and discussion

Be able to summarize, analyze, and discuss the results in a prepared format

- In principle, the text on the part for the student to implement should be prepared in the forms of brackets, blank spaces, and fill-in-the-blank tables.
- Describe in detail the experiment method and the use of equipment.
- Describe the experiment procedures in advance.
- Provide tables, blanks, or forms to describe the results.
- Describe the method or procedures for analysis and discussion.
- It is also acceptable to create a frame (e.g., 50 words or less) that specifies the amount of brackets and sentences in a way that guides students to the experiment results, analysis, and discussion.

○ Preparing a Manual for Achievement Level 2 (LV2）

Planning and implementation

Be able to conduct experiments by oneself based on the prepared procedures

Preparation and operation of equipment and instruments

Be able to use laboratory equipment and instruments correctly according to the operation manual

Results, analysis, and discussion

Be able to summarize, analyze, and discuss the results according to the instructions

- In principle, a detailed and careful manual should be prepared so that students can conduct experiments while reading the experiment manual.
- Describe the experiment method and the use of equipment in detail.
- Describe the experiment procedures in advance.

- Describe the methods for analysis and discussion.
- To render the student capable of implementing experiments without the advice of an instructor, the method, equipment use, and procedures of each experiment should be made clear by such means as illustrating the equipment to use.

○ Preparing a Manual for Achievement Level 3 (LV3）

Planning and implementation

Be able to conduct basic experiments by oneself

Preparation and operation of equipment and instruments

Be able to prepare and operate the necessary laboratory equipment and instruments

Results, analysis, and discussion

Be able to summarize the results according to instructions, and to analyze and discuss the results by oneself

- In principle, a manual should be prepared so that students can conduct experiments by themselves.
- A separate manual on experiment methods and the use of equipment should be prepared so that students can perform basic operations.
- The experiment procedures should not be described in detail. Only instructions should be given.
- Analysis and discussion should be given only as instructions, and students should be encouraged to think by themselves.
- To render students able to implement experiments by themselves, the manuals should be made in such a way that they include references and refer to the manuals that are available in the laboratory.

Title: Write the title of the practical training (experiment) according to the syllabus.

1. Objective

Describe what the student can clarify and learn through this practical training (experiment) in a concrete and concise way.

2. Principle/Theory

Based on the theory behind the practical training (experiment), describe concisely and clearly how the objective can be achieved by conducting this practical training (experiment) including the principle of the experiment and the characteristics of the experiment devices.

It is not necessary to mention fundamental topics such as the definitions of basic terms and laws that are written in textbooks and theoretical discussions.

3. Experiment Method

3.1 Experiment Apparatus

Describe the equipment used in the practical training (experiment) with the manufacturer names and model numbers of the devices.

3.2 Experiment Procedures

Describe the practical training (experiment) procedures in a concise, concrete, and orderly way so that the student can conduct the same experiment by reading the description.

4. Results

Explain the results obtained through the practical training (experiment) by using tables and figures effectively. Compare the experiment results with the theoretical values obtained in advance. Be sure to use sentences to explain what was obtained as a result; do not just list tables and figures. Describe only the facts obtained through the experiment without any personal consideration or impression. Prepare formats of tables and figures so that the student can easily fill them out with the results.

5. Discussion

Describe what was (or was not) clarified through the results of the practical training (experiment) for what was written in the objective. If there is a difference between the theoretical value and the experiment result, analyze the cause of the difference on a scientific basis. Prepare themes and questions to answer after the practical training (experiment) so that the student can fill them out easily.

References

Describe the referenced materials with numbers in the order of citation. Sources including the following can be used as references: books, academic journals, reports of universities and research institutes, and reports and white papers of government agencies. If a website is referred to, the URL and the date of access must be cited.

Measurement of Voltage, Current and Resistance in DC Circuits (Lv.1)

1. Objective

To learn how to measure voltage, current, and resistance of a DC circuit using a tester.

2. Theory

What is a tester?

It is a very convenient measuring instrument for circuit inspection. It is designed to measure a wide range of voltages, currents, and resistances by switching the range. Testers are indispensable for the maintenance and repair of electrical equipment, but they are not suitable for precise measurements due to their relatively wide tolerance range. However, when precision measurement is not required (maintenance, repair, etc.), testers are very easy to handle and can be very effective.

3. Experiment

3.1 Equipmental Setup & Materials

Tester
AA batteries
Battery box
Fixed resistor R_1:330Ω, R_2:150Ω, R_3:100Ω
Wiring Wire
Electric Clip

3.2 Experimental method

3.2.1 Measurement of resistance

Measure the resistance values of resistors $R_1 \sim R_3$.

[Experimental procedure]

- Read the color code of the resistor to be measured and confirm the nominal resistance value.
- Set the dial of the tester to the appropriate resistance range.
- Short-circuit the tester's probe and make a 0 Ohm adjustment.
- Place the probe on both ends of the resistance to be measured and read the tester's probe.

Table 1. Measurement results of resistance

	Color code	Nominal value of resistance	Measured value of resistance
R_1			
R_2			
R_3			

3.2.2 Measurement of voltage

Measure the voltage E, V_1~V_3 of the circuit shown in Figure 1, respectively.

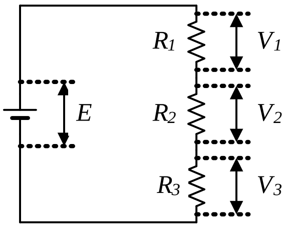


Figure 1: Voltage measurement circuit

[Experimental Procedure]

- Connect three resistors in series with Electric Clips.
- Place the battery in the battery box and connect the resistors with the Electric Clips.
- Set the dial of the tester to the appropriate DC voltage range, anticipating the voltage value to be measured.
- Place a probe on both ends of the battery and measure the battery voltage E.
- Put probes on both ends of each resistor and measure the voltage at both ends of each resistor.

Table 2. Voltage measurement results

E		V_1		V_2		V_3	

3.2.3 Measurement of current

Measure the current I_1~I_3 of the circuit shown in Figure 2 respectively.

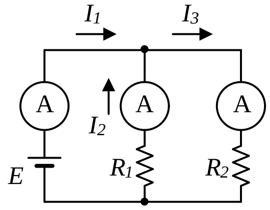


Figure 2: Current measurement circuit

[Experimental procedure]

- Connect the battery and resistors R_1 and R_2 in parallel using a wire and an Electric Clip.
- Connect the red probe of the tester to the wire coming out of the positive side of the battery box, and the black probe to one side of the resistors connected in parallel with an Electric Clip. At this time, do not install the battery yet.
- Use a minnow clip to connect the other side of the parallel resistor to the wire coming out of the negative side of the battery box.
- Anticipate the current to be measured, and set the dial on the tester to the appropriate current range.
- After installing the battery, read the tester's pointer and measure the current I1.
- After removing the battery, insert the tester into a place where I2 can be measured as I3, install the battery in the same way, read the tester's pointer, and measure the current I2 and I3 respectively. The red probe should be connected to the one with the higher voltage.

Table 3. Current measurement results

I_1		I_2		I_3	

4. Discussion

[1] Calculate the error between the measured value and the nominal value obtained from the resistance measurement, and discuss the cause of the error. Note that the tolerance of the resistor itself is shown in the fourth band of the color code.

[2] From the measured voltage, examine the relationship between E and V_1 to V_3 in Figure 1.

[3] From the measured current, what is the relationship between I_1 and I_3 in Figure 2.

Kirchhoff's Law (Lv.2)

1. Objective

Confirmation of Kirchhoff's law by experiment

2. Theory

2.1 Kirchhoff's First Law (Current Law)

At any point in an electric circuit, the sum of the currents flowing into and out of that point is zero. For example, suppose that currents I_1 and I_2 flow into and I_1 flows out of node a of the circuit shown in Figure 1(a).

If the direction of flow in is positive and the direction of flow out is negative, then the following equation holds

$$I_1 + I_2 - I_3 = 0 \qquad (1)$$

2.2 Kirchhoff's Second Law (Voltage law)

When following any closed circuit (closed circuit) in an electric circuit in one direction, the sum of the voltage drop and the sum of the electromotive force in that closed circuit are equal. For example, in a closed circuit like the one shown in Fig. 1(b), if the clockwise direction is positive, then the following equation holds

$$\mathrm{E} = V_1 + V_2 = IR_1 + IR_2 \qquad (2)$$

(a) First Law (Current Law) (b) Second Law (Voltage Law)

Figure 1: Kirchhoff's law

3. Experiment

3.1 Equipment Setup & Materials

Tester : 2 units

D.C. variable bench supply

Fixed resistors 1kΩ×2pcs, 2kΩ

Rheostat(Variable resistors) 2kΩ

Wiring Wire

Electric Clip

3.2 Experimental method

For the circuit shown in Fig. 2, change the resistance R_4 (Variable resistors) and measure the current I_1 to I_4 and the voltage V_1 to V_4 , $R_1 = 1[\mathrm{k\Omega}]$, $R_2 = 2[\mathrm{k\Omega}]$, $R_3 = 1[\mathrm{k\Omega}]$ and $E = 5[\mathrm{V}]$.

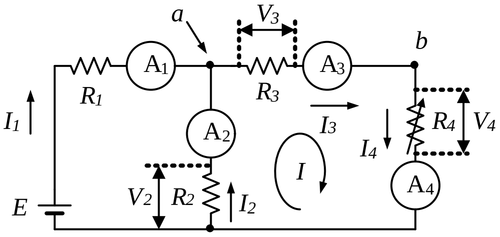


Fig. 2 Test Circuit

[Experimental procedure]

1. Circuit construction

- Connect the resistors R_1 to R_3 and the DC variable bench supply with a wiring cable, referring to Fig. 2. The circuit should be constructed taking into account that a rheostat should be connected to R_4 later, and a tester should be connected to A_1-A_4 and V_2-V_4. The voltage of the power supply should be 5V.

2. Setting of R_4 (measurement of resistance)

- Adjust the rheostat R_4 and measure the resistance value with a tester.

  (The rheostat R_4 shall be turned fully to the left and fully to the right, plus three points in between, for a total of five points, repeat steps 3 to 4 below.

3. Measurement of the current

- Connect R_4 to the circuit and connect the tester to the place where you want to measure the current (any of A_1 to A_4). At this point, pay attention to the polarity, considering the direction in which the current actually flows.
- After setting the tester to the appropriate current range, turn the power on.
- Read the current value with the tester and enter it in Table 1.

4. Measuring the voltage

- Turn off the power supply and connect the tester to the place where you want to measure the voltage (one of V_2 to V_4). At this point, pay attention to the polarity, considering the positive and negative of the voltage.
- After setting the tester to the appropriate DC voltage range, turn the voltage ON.
- Read the voltage value on the tester and record it in Table 1.
- Turn off the power supply and remove R_4 from the circuit, then go back to "Setting of R_4" and repeat the same procedure.

Table 1. Results of resistance measurement

$R_4[\Omega]$	I_1[A]	I_2[A]	I_3[A]	I_4[A]	V_2[V]	V_3[V]	V_4[V]	State of R_4
								Turned fully to the left
								Turned fully to the right

4. Discussion

[1] For each measurement, consider whether the currents I_1 to I_4 at nodes *a* and *b* satisfy the first law of Kirchhoff's law.

[2] For each measurement, consider whether the voltages V_2 to V_4 in the closed circuit consisting of R_1 to R_4 satisfy Kirchhoff's second law.

Kirchhoff's Law (Lv.3)

1. Objective

Experiments to verify Kirchhoff's law, the Superposition theorem and Thevenin's law.

2. Theory

2.1 Kirchhoff's law

Current law: At any point in an electric circuit, the sum of the currents flowing into and out of that point is zero.

Voltage law: If we follow any electric closed circuit in one direction, the sum of the voltage drop and the sum of the electromotive forces in that closed circuit are equal.

2.2 Superposition theorem

The current flowing in each branch of a network containing two or more electromotive forces is equal to the sum of the currents in each branch calculated separately (superposition), assuming that each electromotive force exists alone in the network.

2.3 Thevenin's law

A circuit network can be represented by an equivalent circuit consisting of a voltage source V_0 and a resistor R_0 connected in series, regardless of its internal structure. Here, V_0 is the voltage between the terminals of the power supply circuit when it is open (open circuit voltage) and R_0 is the resistance between the terminals when it is short-circuited (short-circuit removal) by removing all the power supply in the circuit.

3. Experiment

3.1 Equipmental Setup & Materials

Tester

D.C. variable bench supply : 2 units

Fixed resistors 160Ω, 560Ω, 820Ω

Wiring Wire

Electric Clip

3.2 Experimental method

3.2.1 Superposition theorem

Construct a circuit as shown in Fig. 1 and measure the current at each point in the circuit. Furthermore, measure the current in the same way with no power supply on one side, as shown in Fig. 2 and Fig. 3. However, assume that R_1=560[Ω], R_2=560[Ω], R_3=560[Ω], E_1=8.8[V] and E_2=11.4[V].

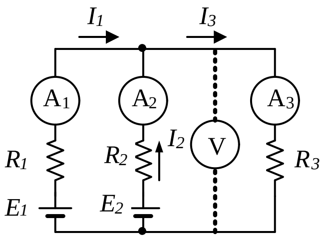


Figure 1

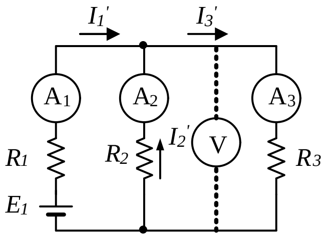
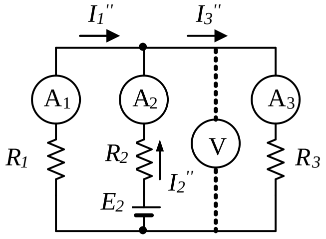


Figure 2



Fgure 3

[Experimental procedure]

- Measure the current of I_1 to I_3 with a tester.
- Remove E_2, short-circuit both ends (Fig. 2) and measure the current from I_1' to I_3' with a tester.
- Remove E_1, short-circuit both ends (Fig. 3) and measure the current from I_1'' to I_3'' with a tester.

3.2.2 Thevenin's law

Take the part of the circuit shown in Fig. 1 consisting of E_1, E_2, R_1 and R_2 as the power supply circuit and measure the voltage value in the open state with R_3 removed. Also, measure the resistance of the power supply circuit with the power supply removed. Based on these voltage and resistance values, construct an equivalent circuit for the power supply circuit and measure the current flowing through the circuit. The resistors R_1 to R_3 and the value of the electromotive force E should be the same as in the experiment in 1.

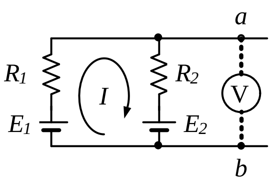


Figure 4

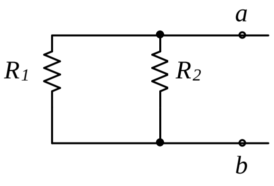
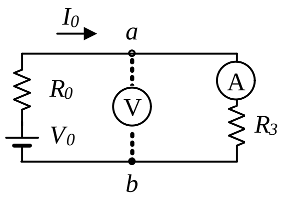


Figure 5



Fgure 6

[Experimental procedure]

- Measure the voltage V_0 between terminals *a* and *b* in Fig. 4 with a tester.
- Remove E_1 and E_2 and short-circuit them respectively to make the circuit of Fig. 5, and measure the resistance R_0 between terminals *a* and *b* with a tester.
- Make the circuit shown in Fig. 6 and measure the current I_0 with a tester. However, V_0 and R_0 should be the values obtained in the above measurement.

4. Discussion

[1] Compare the theoretical and measured values of the currents I_1~I_3, I_1' ~I_3' and I_1' ~I_3'', respectively, using Kirchhoff's law for the experiment of 1 Compare the theoretical values with the measured values.

[2] Show that the superposition theorem holds for the circuits shown in Fig. 2 and Fig. 3 of the experiment in 1 using the current values obtained in the experiment.

[3] Compare and discuss the measured and theoretical values of the resistance in Fig. 5 for the experiment of 2.

[4] In response to the experiment in 2, show that Fig. 6 is the same circuit as Fig. 1 (equivalent circuit), using Thevenin's law.

Experiment Theme: Measurement of Voltage, Current and Resistance in DC Circuits, Kirchhoff's Law

Item	Skill	Goal	Level 1	Level 2	Level 3
Planning and Execution	Voltage and current measurement	Can measure voltage and current.	Measure voltage and current by filling in the tables in the lab manual.	Measure voltage and current according to experimental procedures.	To be able to measure voltage and current by oneself
Planning and Execution	DC circuits	Able to create a DC circuit according to a circuit diagram using resistors and power supplies	Create a simple DC circuit by following the experimental procedures.	Create a DC circuit according to the experimental procedures.	To be able to create a DC circuit by oneself
Preparation and operation of equipment and instruments	Testers, D.C. variable bench supply	To be able to use testers and D.C. variable bench supply	Operate a tester and a D.C. variable bench supply with an appropriate understanding of the detailed instructions for use	Operate a tester and a D.C. variable bench supply with an appropriate understanding of the methods described in the experimental manual	Understand the necessity of testers and D.C. variable bench supplies, and to be able to operate them by onself.
Results, analysis, and discussion	Kirchhoff's law, Superposition Theorem, Thevenin's law	Explain the results of experiments using Kirchhoff's law, the Superposition theorem, and Thevenin's law	Explain the results of experiments using Kirchhoff's law, based on the methods and procedures described in detail	To be able to explain the results of experiments using Kirchhoff's law according to the described method	To be able to think independently and explain the results of experiments using Kirchhoff's law, Superposition theorem and Thevenin's law

Appendix 1-6: Brochure for PR

PROJECT BACKGROUND

The National Skill Development Policy 2011 (NSDP 2011), which aims to produce high-quality and skilled human resources, can sustain economic growth in Bangladesh.

Despite this policy initiative, there is a survey which points out the number of engineers who can realize industrial diversification and high added value, and who are capable of improving productivity and creating new value through logical and critical thinking, are limited. To achieve a post-garment industry transformation of the industrial structure, the education sector must develop to fill that gap. Thus, this project is packaged to develop a technical education model to produce well-educated and skilled human resources through improving teaching materials, capacity of lecturers of technical education (Polytechnic education) and capacity building of Technical Teachers Training College and Polytechnic institute.

Counterpart Agency-

Directorate of Technical Education (DTE),
Ministry of Education

Strengthen collaboration with Industry

The project is supporting to strengthen collaboration between industry and pilot polytechnic institutes through various job placement support activities. As a first step, 3 students from DPI were accepted as internships in 2 Japanese companies based in Dhaka.

Contact Us

Project Office

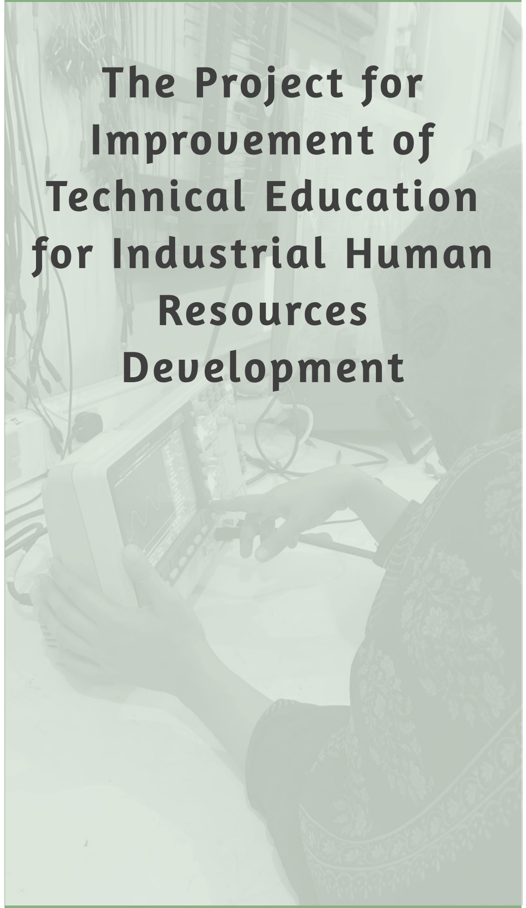
Address: Directorate of Technical Education,
5th floor, F-4/B, Sher-E-Bangla
Nagar, Agargaon, Dhaka- 1207

Contact: techeduproject.jp.bd@gmail.com

+88-01799919768

Please visit our Facebook page

https://www.facebook.com/
JICABangladesh.TCP.ImprovementOfTechnicalEducaiton



The Project for Improvement of Technical Education for Industrial Human Resources Development

PROJECT GENERAL INFORMATIONS

Project Purpose-

This project aims that human resources are nurtured at the pilot polytechnic institutes in Bangladesh through improved technical education in the fields of electrical, electronics, mechanical and computer technologies, based on the needs of industry.

Based on the education method of KOSEN (Japanese National Institute of Technology) and the needs of industry, we are aiming to develop human resources with basic technical capabilities who can deal with any kind of development and diversification of Industry through lecturer training conducted by KOSEN professors.

Target Areas-

- Dhaka Polytechnic Institute (DPI)
- Dhaka Mohila Polytechnic Institute (DMPI)
- Another Polytechnic Institute outside Dhaka City will be chosen as the pilot polytechnic institutes
- The technical education model developed in the Project will be disseminated to other polytechnic institutes through the Technical Teachers Training College (TTTC).

Contents of activities-

In order to fulfill following objectives, we are providing several activities.

① Framework for improving technical education

- ∗Establishment of working group
- ∗Selection of model subjects
- ∗Development of action plan

② Technical Education Improvement

- ∗Development of hands-on manuals
- ∗Teacher training by KOSEN professors
- ∗Verification of improved technical education
- ∗Development of guideline

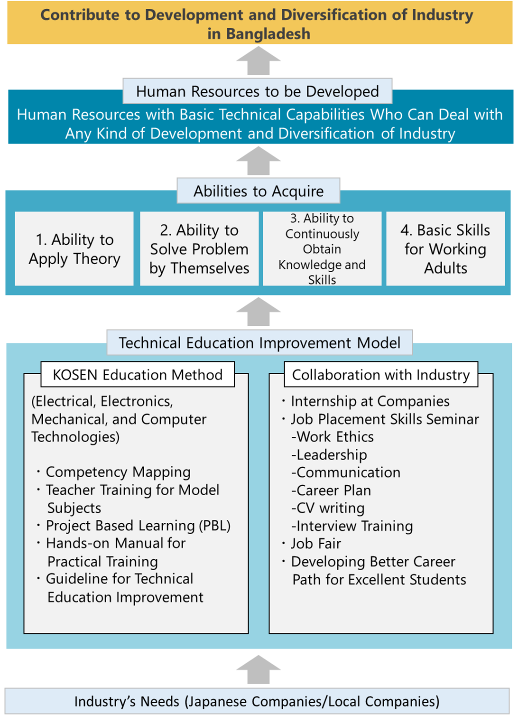
③ Strengthen collaboration with Industry

- ∗Development of action plan for job Placement
- ∗Information collection on private companies
- ∗Job seminars/events
- ∗Internship
- ∗Job Matching

PROJECT ROADMAP designed by KOSEN Professors

The project sets a roadmap of human resource development plan for Phase 1 of this project.

As a technical education model for achieving the project goal, rather than enhancing the specialization of a specific subject, this project focuses on teaching how to teach practical lessons to learn the below-mentioned ability through TOT of model subjects, PBL, and development of practical teaching materials.



Contribute to Development and Diversification of Industry in Bangladesh

Human Resources to be Developed

Human Resources with Basic Technical Capabilities Who Can Deal with Any Kind of Development and Diversification of Industry

Abilities to Acquire

1. Ability to Apply Theory
2. Ability to Solve Problem by Themselves
3. Ability to Continuously Obtain Knowledge and Skills
4. Basic Skills for Working Adults

Technical Education Improvement Model

KOSEN Education Method

(Electrical, Electronics, Mechanical, and Computer Technologies)

- Competency Mapping
- Teacher Training for Model Subjects
- Project Based Learning (PBL)
- Hands-on Manual for Practical Training
- Guideline for Technical Education Improvement

Collaboration with Industry

- Internship at Companies
- Job Placement Skills Seminar
  - -Work Ethics
  - -Leadership
  - -Communication
  - -Career Plan
  - -CV writing
  - -Interview Training
- Job Fair
- Developing Better Career Path for Excellent Students

Industry's Needs (Japanese Companies/Local Companies)

Appendix 2-1: PDM

Project Design Matrix (PDM)

Project Title: Project for Improvement of Technical Education for Industrial Human Resources Development

Implementing Agency: Directorate of Technical Education, Ministry of Education, Bangladesh Technical Education Board (BTEB),
Technical Teachers Training College (TTTC), Pilot polytechnic Institutes

Target Group: Faculty members and students (Electrical, Electronics, Mechanical and Computer technologies) of Dhaka Polytechnic Institute,
Dhaka Mohila Polytechnic Institute, one polytechnic institute outside Dhaka City and Technical Teachers Training College (TTTC)

Period of Project: February 2019 - February 2024

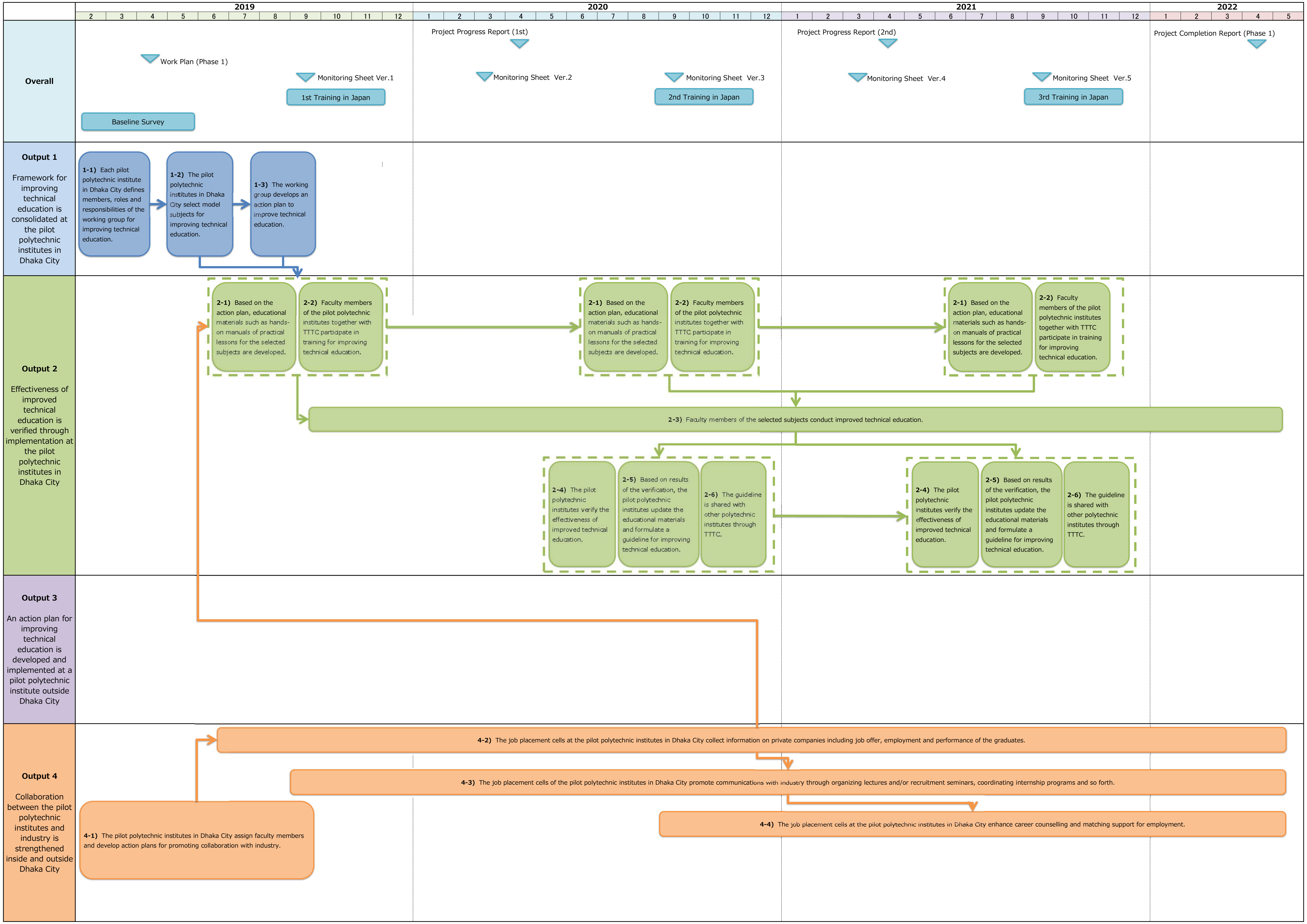
Project Site: **Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal A technical education model, which is developed at the pilot polytechnic iinstitutes, becomes widely used at other polytechnic institutes.	• Number of training events organized by DTE to isseminate the technical education model • Number of polytechnic institutes and faculty members of polytechnic institutes that participate in the training		
Project Purpose Based on the needs of industry, human resources are nurtured at the pilot polytechnic institutes through improved technical education in the fields of electrical, electronics, mechanical and computer technologies.	• Satisfaction level of students on technical education at the polytechnic institutes • Percentage of the graduates employed among those who wanted to get a job • Satisfaction level of companies on the performance of the graduates	• Records of the pilot polytechnic institutes • Records of the job placement cells • Results of questionnaire surveys and interviews with companies	Policies for improving technical education remain unchanged.
Outputs 1. Framework for improving technical education is consolidated at the pilot polytechnic institutes in Dhaka City.	• A working group established for improving technical education at each pilot polytechnic institute in Dhaka City • An action plan to improve technical education at each pilot polytechnic institute in Dhaka City	• Records of the pilot polytechnic institutes • Project monitoring sheet	Social economic enviroment does not deteriorate.
2. Effectiveness of improved technical education is verified through implementation at the pilot polytechnic institutes in Dhaka City.	• Number of monitoring on the progress of the action plan • Number of faculty members who participated in developing a guideline for improving technical education • Number of hands-on manuals verified • A guideline for improving technical education verified • Number of training events given by TTTC for polytechnic institutes	• Project monitoring sheet • Records of the pilot polytechnic institutes • Project monitoring sheet • Project monitoring sheet • Records of TTTC	
3. An action plan for improving technical education is developed and implemented at a pilot polytechnic institute outside Dhaka City.	• A working group established for improving technical education at a pilot polytechnic institute outside Dhaka City • Number of faculty members who participated in developing an action plan for improving technical education • Number of monitoring on the progress of the action plan • Number of hands-on manuals developed • Number of training events given by TTTC for a pilot polytechnic institute outside Dhaka City	• Project monitoring sheet • Records of the pilot polytechnic institute • Project monitoring sheet • Project monitorinq sheet • Project monitorinq sheet	
4. Collaboration between the pilot polytechnic institutes and industry is strengthened inside and outside Dhaka City.	• Number of activities implemented by the job placement cells • Number of job matching by utilizing information of companies • Number of events with companies, such as training, internship, site tour and number of students participated • Number of students who had career counselling • Number of companies that collaborated with the pilot polytechnic institutes • Satisfaction level of students regarding the job placement conducted by the pilot polytechnic institutes	• Records of the job placement cells • Records of the job placement cells • Records of the job placement cells • Records of the job placement cells • Records of the job placement cells • Results of questionnaire surveys and interviews with students	

Activities	Inputs		
	The Japanese Side	The Bangladesh Side	
1.1 Each pilot polytechnic institute in Dhaka City defines members,roles and responsibilities of the working group for improving technical education. 1.2 The pilot polytechnic institutes in Dhaka City select model subjects for improving technical education. 1.3 The working group develops an action plan to improve technical education. 2.1 Based on the action plan, educational materials such as hands-on manuals of practical lessons for the selected subjects are developed. 2.2 Faculty members of the pilot polytechnic institutes together with TTTC participate in training for improving technical education. 2.3 Faculty members of the selected subjects conduct improved technical education. 2.4 The pilot polytechnic institutes verify the effectiveness of improved technical education. 2.5 Based on results of the verification, the pilot polytechnic institutes update the educational materials and formulate a guideline for improving technical education. 2.6 The guideline is shared with other polytechnic institutes through TTTC. 3.1 A polytechnic institute located outside Dhaka City is selected as a pilot polytechnic institute that improves technical education following the guideline developed and verified through the activities for Output 1 and 2. 3.2 The selected pilot polytechnic institute develops an action plan, referring to the guideline developed and verified through the activities for Output 1 and 2. 3.3 The selected pilot polytechnic institute implements and monitors the action plan. 3.4 The selected pilot polytechnic institute updates the action plan and educational materials. 4.1 The pilot polytechnic institutes in Dhaka City assign faculty members and develop action plans for promoting collaboration with industry. 4.2 The job placement cells at the pilot polytechnic institutes in Dhaka City collect information on private companies including job offer, employment and performance of the graduates. 4.3 The job placement cells of the pilot polytechnic institutes in Dhaka City promote communications with industry through organizing lectures and/or recruitment seminars, coordinating internship programs and so forth. 4.4 The job placement cells at the pilot polytechnic institutes in Dhaka City enhance career counselling and matching support for employment. 4.5 The pilot polytechnic institute outside Dhaka City assigns faculty member(s) and develops an action plan for promoting collaboration with industry, referring to the activities at the pilot polytechnic institutes in Dhaka City and according to the local socio-economic environment of its own. 4.6 The pilot polytechnic institute outside Dhaka City implements the action plan for promoting collaboration with industry.	✔Dispatch of experts (Chief Advisor, Collaboration with industry, Training Planning/Material Development, Electrical, Electronics, Mechanical and Computer technologies) ✔Local staff: Project officer, Interpreter ✔Training in Japan ✔Materials for technical education at the pilot polytechnic institutes, including those for practical training ✔Minimum equipment needed for technical education in the fields of electrical, electronics, mechanical and computer technologies at the pilot polytechnic institutes and TTTC ✔Other expenses needed for project operation	✔Counterpart personnel • Project Director • Project Manager ✔Facility: Office space for JICA experts at DTE and the pilot polytechnic institutes ✔Maintenance cost for equipment of technical education ✔Cost for meetings and discussion at the pilot polytechnic institutes ✔Other expenses	DTE maintains its policy to boost the motivation of the principals of polytechnic institutes for improving technical education. Pre-Conditions <Issues and countermesures>

Appendix 2-2-1: Workflow chart (Original)

Workflow Chart (Original)



Output 1

Framework for improving technical education is consolidated at the pilot polytechnic institutes in Dhaka City

1-1) Each pilot polytechnic institute in Dhaka City defines members, roles and responsibilities of the working group for improving technical education.

1-2) The pilot polytechnic institutes in Dhaka City select model subjects for improving technical education.

1-3) The working group develops an action plan to improve technical education.

Output 2

Effectiveness of improved technical education is verified through implementation at the pilot polytechnic institutes in Dhaka City

2-1) Based on the action plan, educational materials such as hands-on manuals of practical lessons for the selected subjects are developed.

2-2) Faculty members of the pilot polytechnic institutes together with TTTC participate in training for improving technical education.

2-3) Faculty members of the selected subjects conduct improved technical education.

2-4) The pilot polytechnic institutes verify the effectiveness of improved technical education.

2-5) Based on results of the verification, the pilot polytechnic institutes update the educational materials and formulate a guideline for improving technical education.

2-6) The guideline is shared with other polytechnic institutes through TTTC.

Output 3

An action plan for improving technical education is developed and implemented at a pilot polytechnic institute outside Dhaka City

Output 4

Collaboration between the pilot polytechnic institutes and industry is strengthened inside and outside Dhaka City

4-1) The pilot polytechnic institutes in Dhaka City assign faculty members and develop action plans for promoting collaboration with industry.

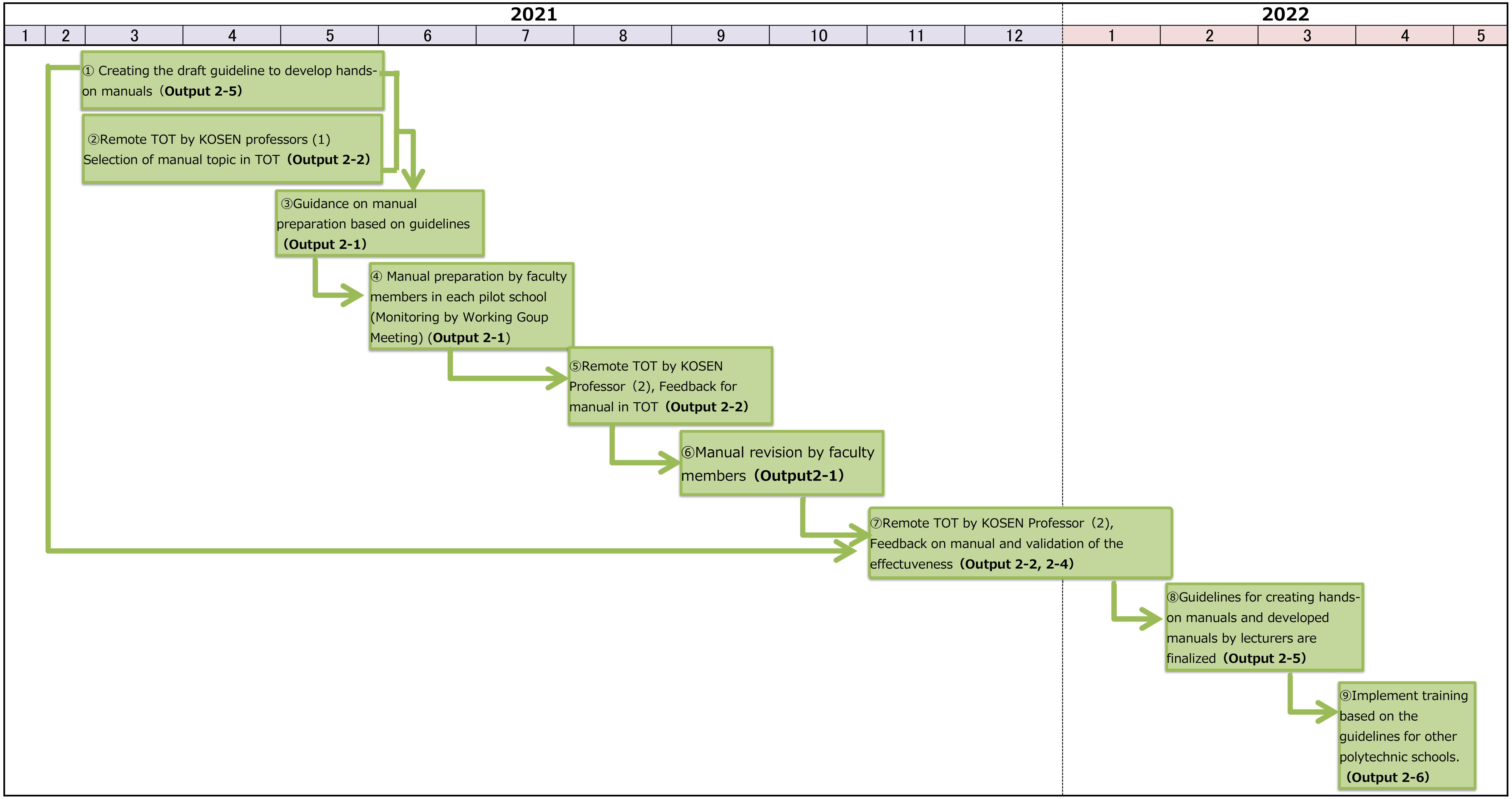
4-2) The job placement cells at the pilot polytechnic institutes in Dhaka City collect information on private companies including job offer, employment and performance of the graduates.

4-3) The job placement cells of the pilot polytechnic institutes in Dhaka City promote communications with industry through organizing lectures and/or recruitment seminars, coordinating internship programs and so forth.

4-4) The job placement cells at the pilot polytechnic institutes in Dhaka City enhance career counselling and matching support for employment.

Appendix 2-2-2: Workflow chart (Revised)

Workflow Chart (Revised)



① Creating the draft guideline to develop hands-on manuals（**Output 2-5**）

②Remote TOT by KOSEN professors (1) Selection of manual topic in TOT（**Output 2-2**）

③Guidance on manual preparation based on guidelines（**Output 2-1**）

④ Manual preparation by faculty members in each pilot school (Monitoring by Working Goup Meeting) (**Output 2-1**)

⑤Remote TOT by KOSEN Professor（2), Feedback for manual in TOT（**Output 2-2**）

⑥Manual revision by faculty members（**Output2-1**）

⑦Remote TOT by KOSEN Professor（2), Feedback on manual and validation of the effectuveness（**Output 2-2, 2-4**）

⑧Guidelines for creating hands-on manuals and developed manuals by lecturers are finalized（**Output 2-5**）

⑨Implement training based on the guidelines for other polytechnic schools.（**Output 2-6**）

Appendix 2-3: Personnel assignment schedule

Personnel Assignment Schedule

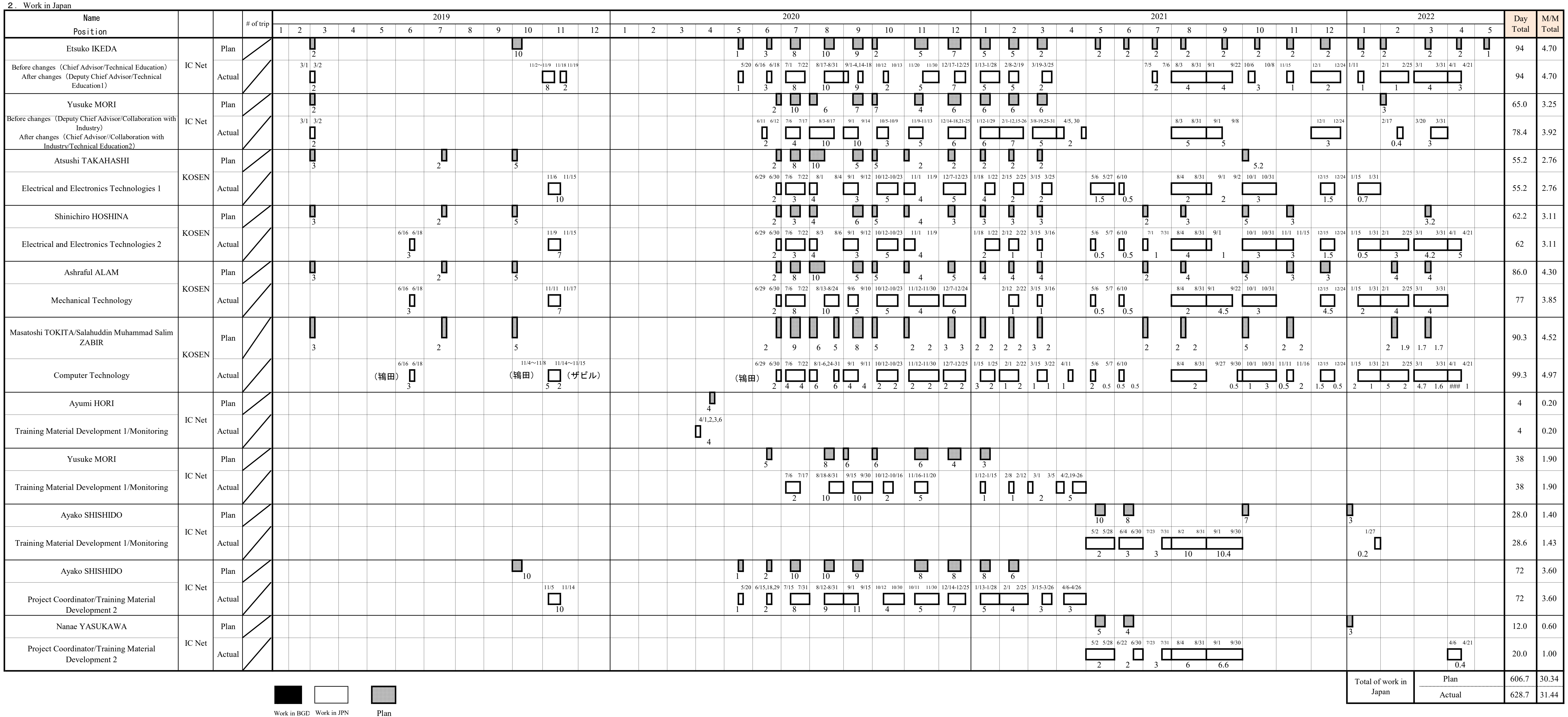
Project for improvement of technical education for industrial human resources development (1st period)

１．Work in Bangladesh

Name Position	Affiliation		# of trip	2019	2020	2021	2022	Day Total	M/M Total
Etsuko IKEDA	IC Net	Plan	4	12 14 8 8 13				55	1.83
		Quarantine						0	0.00
Before changes（Chief Advisor/Technical Education） After changes（Deputy Chief Advisor/Technical Education1）		Actual	4	4/15 4/26 12 6/24 7/7 7 7 8/19 9/3 13 3 12/1 12/13 13				55	1.83
Yusuke MORI	IC Net	Plan	11	14 14 14	13 14	4 10 19 17 19	18 14	170	5.67
		Quarantine				9/11 9/24 14		14	0.47
Before changes（Deputy Chief Advisor/Collaboration with Industry） After changes（Chief Advisor//Collaboration with Industry/Technical Education2）		Actual	10	4/17 4/30 14 6/24 7/7 7 7 8/31 9/14 1 14 11/26 12/7 5 7	1/13 1/26 14 3/1 3/14 14	9/9,10 9/25, 27-29 6 10/21 10/31 11 11/1 11/7 7	2/1 2/12 12 3/5 3/19 15 4/3 4/18 16	150	5.00
Atsushi TAKAHASHI	KOSEN	Plan	1	8				8	0.27
		Quarantine						0	0.00
Electrical and Electronics Technologies 1		Actual	1	9/7 9/14 8				8	0.27
Shinichiro HOSHINA	KOSEN	Plan	2	9 8				17	0.57
		Quarantine						0	0.00
Electrical and Electronics Technologies 2		Actual	2	6/29 7/7 2 7 9/7 9/14 8				17	0.57
Ashraful ALAM	KOSEN	Plan	2	10 8				18	0.60
		Quarantine						0	0.00
Mechanical Technology		Actual	2	6/24 7/3 7 3 9/7 9/14 8				18	0.60
Masatoshi TOKITA/Salahuddin Muhammad Salim ZABIR	KOSEN	Plan	2	10 8				18	0.60
		Quarantine						0	0.00
Computer Technology		Actual	2	6/24 7/3 7 3（鴇田） 9/7 9/14 8（鴇田）				18	0.60
Ayumi HORI	IC Net	Plan	3	14 14 11				39	1.30
Training Material Development 1/Monitoring		Actual	3	4/14 4/26 13 6/24 7/7 7 7 9/3 9/14 12				39	1.30
Yusuke MORI	IC Net	Plan	0					0	0.00
		Quarantine						0	0.00
Training Material Development 1/Monitoring		Actual	0					0	0.00
Ayako SHISHIDO	IC Net	Plan	4			8 8 14	14 7 10	61	2.03
		Quarantine				10/25 10/30 6		6	0.20
Training Material Development 1/Monitoring		Actual	2			10/23,24,31 3 11/1 11/27 27	3/26 4/24 6 24	60	2.00
Ayako SHISHIDO	IC Net	Plan	5	14 14 4 10 13	13			68	2.27
		Quarantine						0	0.00
Project Coordinator/Training Material Development 2		Actual	5	4/17 4/30 14 6/29 7/10 2 10 8/19 9/3 13 3 12/1 12/13 13	3/1 3/13 13			68	2.27
Nanae YASUKAWA	IC Net	Plan	3			9 7 10	10	36	1.20
		Quarantine						0	0.00
Project Coordinator/Training Material Development 2		Actual	2			11/20 11/29 10	3/23 4/5 9 5	24	0.80

Total of work in Bangladesh		Day Total	M/M Total
Total of work in Bangladesh	Plan	490	16.34
	Actual	457	15.24

２．Work in Japan



Name Position			Day Total	M/M Total
Etsuko IKEDA	IC Net	Plan	94	4.70
Before changes（Chief Advisor/Technical Education） After changes（Deputy Chief Advisor/Technical Education1）		Actual	94	4.70
Yusuke MORI	IC Net	Plan	65.0	3.25
Before changes（Deputy Chief Advisor/Collaboration with Industry） After changes（Chief Advisor//Collaboration with Industry/Technical Education2）		Actual	78.4	3.92
Atsushi TAKAHASHI	KOSEN	Plan	55.2	2.76
Electrical and Electronics Technologies 1		Actual	55.2	2.76
Shinichiro HOSHINA	KOSEN	Plan	62.2	3.11
Electrical and Electronics Technologies 2		Actual	62	3.11
Ashraful ALAM	KOSEN	Plan	86.0	4.30
Mechanical Technology		Actual	77	3.85
Masatoshi TOKITA/Salahuddin Muhammad Salim ZABIR	KOSEN	Plan	90.3	4.52
Computer Technology		Actual	99.3	4.97
Ayumi HORI	IC Net	Plan	4	0.20
Training Material Development 1/Monitoring		Actual	4	0.20
Yusuke MORI	IC Net	Plan	38	1.90
Training Material Development 1/Monitoring		Actual	38	1.90
Ayako SHISHIDO	IC Net	Plan	28.0	1.40
Training Material Development 1/Monitoring		Actual	28.6	1.43
Ayako SHISHIDO	IC Net	Plan	72	3.60
Project Coordinator/Training Material Development 2		Actual	72	3.60
Nanae YASUKAWA	IC Net	Plan	12.0	0.60
Project Coordinator/Training Material Development 2		Actual	20.0	1.00

Total of work in Japan	Plan	606.7	30.34
	Actual	628.7	31.44

Total	Plan	1097	46.68
	Actual	1086	46.68

Appendix 2-4: Equipment list

List of equipment provided by JICA

Technology	DPI	DMPI	TTTC
Mechanical	Bernoulli's theorem demonstration apparatus and digital hydraulic bench x 1		Not necessary because TTTC has enough equipment
	Anemometer x 10		
	Air flow in pipe apparatus x 1		
	Centrifugal pump test set x 1		
	Propeller turbine set x 1		
Electrical	Data storage oscilloscope x 4		Data storage oscilloscope x 1
	Function generator x 4		Function generator x 1
Electronics	Parts shelf x 1	Parts shelf x 1	Parts shelf x 1
	Tool box x 1	Tool box x 1	Tool box x 1
	Digital oscilloscope x 1	Digital oscilloscope x 1	Digital oscilloscope x 2
	Logic analyzer x 1	Logic analyzer x 1	Logic analyzer x 4
Computer	PC for server x 1	PC for server x 1	PC for server x 1
	LAN cable 10m x 24	LAN cable 10m x 24	LAN cable 10m x 24
	Server switch x 1	Server switch x 1	Server switch x 1

Bernoulli’s theorem demonstration apparatus and digital hydraulic bench

Air flow in pipe apparatus

Centrifugal pump test set

Propeller turbine set

Anemometer

Data storage oscilloscope

Function generator

Logic analyzer

List of Property Lending

Name of Project: Project for improvement of technical education for inductrial human resources development

Country: Bangladesh

As of January, 2022

Division in Charge: Human Development Division

Name of Property	Standard, Part Number	Quantity	Purchase Price			Date of Inspection Passed	Location	Current State	Remarks	After Completion of Project: Handover/Return
			Purchase Price	Currency	In Japanese Yen					
PC (laptop)	HP PROBOOK 450 G6. :DESKTOP-HI9A99C	2	152,000	BDT	197,795	2019/7/10	Project office (DPI)	in-service		TBD
Multi-function printer	Xerox Versalink C7020	1	423,000	BDT	542,172	2019/9/30	Project office (DTE)	in-service		TBD
Air-conditioning	GENERAL 2ton ASGA24FMTB	2	188,000	BDT	244,862	2019/10/14	Project office (DTE)	in-service		TBD
PC (laptop)	HP PAVILION 15-cs3057TX	1	88,500	BDT	111,021	2020/11/1	Project office (DTE)	in-service		TBD
Air-conditioning	GENERAL 1ton	1	68,000	BDT	86,646	2021/3/22	Project office (DMPI)	in-service		TBD
Learning Management System (LMS)	Educably	1			3,964,000	2021/3/24	Online LMS software package (operated by cloud server)	in-service		TBD
PC (laptop)	HP Intel Core i7-1165G7 Processor (12M Cache, 2.80 GHz up to 4.70 GHz)	1	100,000	BDT	136,157	2022/1/27	Project office (DTE)	in-service		TBD
Rental cloud sever	Rental server for educably	12	19,430		233,160	2022/3/4	Cloud server	in-service		TBD
【Property Lent by JICA】										

Appendix 2-5: Minutes of 1st JCC meeting

MINSUTES OF MEETINGS
OF
1st JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR IMPROVEMENT OF TECHNICAL EDUCATION FOR INDUSTRIAL HUMAN RESOURCES DEVELOPMENT

IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

The 1st Joint Coordinating Committee (hereinafter referred to as "JCC") meeting for the Project for Improvement of Technical Education for Industrial Human Resources Development (hereinafter referred to as "the Project") was held on 26 August 2019, chaired by Mr. Rawnak Mahmud, Additional Secretary and Director General of Directorate of Technical Education (DTE), Technical and Madrasah Education Division, Ministry of Education, at Dhaka, People's Republic of Bangladesh.

As the result of discussions, participants agreed on the issues in documents attached hereto.

河添靖宏

Yasuhiro Kawazoe
Senior Representative,
Japan International Cooperation Agency
Bangladesh Office

18.09.19

Rawnak Mahmud
Additional Secretary
&
Director General,
Directorate of Technical Education,
Technical and Madrasah Education
Division, Ministry of Education

The Attached Document

The 1st JCC meeting was given according to the agenda as given in Annex 1. The list of participants is given in Annex 2. The Work Plan including the Project Design Matrix (PDM) and Work Flow and Plan of Operation of Phase 1[1], was also distributed to all participants.

During the meeting, participants had close discussions as below and agreed the following content of the presentation.

Main Points Discussed:

1. Work Plan
   1-1 Project summary
      - Overall Goal, Project Purpose, 4 Outputs and respective activities given in the PDM were explained. The basic policy of the Project for introducing KOSEN's education method was also explained.
      - The implementation structures of the JCC, which is the decision-making body of the Project, was agreed.

   1-2 Progress of activities during April to August 2019
      - Regarding the selected model subjects, Director (Curriculum) of Bangladesh Technical Education Board (BTEB) raised point that all subjects, not one for each technology, should be targeted in order to improve the system of technical education in Bangladesh. The Chairperson explained that the Project was aiming to establish and verify the model and disseminate the successful model to technical institutions. The representative of the Japanese Commerce and Industry Association in Dhaka introduced his experience at KOSEN in Japan, referring to the gap between Bangladesh and Japan, and suggested that changing mindset or philosophy of education through the model subject should be the priority.
      - Regarding the selection of the model subject, the representative of the Federation of Bangladesh Chambers of Commerce and Industry (FBCCI) asked the relevance between business development and the selected

---

[1] The Project is divided into 2 Phases: Phase 1 is from February 2019 to May 2022 and Phase 2 is from June 2022 to February 2024.

technical subjects. The Chairperson stressed that the model subjects were selected by the Working Groups including industries and KOSEN professors.

1-3 Planned activities from September 2019 to February 2020

- Regarding the action plan, based on the role and responsibility of the Working Group, it was confirmed that the action plan to improve technical education should be developed during the training in Japan and that the draft action plan would be finalized in the Working Group to be held in December 2019. The Job Placement Cell is drafting its own action plan at each pilot institute.
- Regarding the 1st trial training of trainers (TOT), the Project Team provided detailed information that it would be conducted at TTTC in early September and followed by the 1st official training of TOT in February 2020.

1-4 Establishment of the Working Group

- Working Group members of the pilot polytechnic institutes were confirmed.

1-5 Outline of the 1st training in Japan in 2019

- Objectives and expected outcomes were explained, although details are still tentative.

1-6 Others

A proposal to include a TSC in the Project as a pilot institute was raised by the Principal of Technical School and College. The Chairperson replied that it is considered for the Phase 2. JICA Representative replied that as there are already 2 pilot institutes in the 1st phase, TSC could be considered as pilot institute in the 2nd phase.

2. 2nd JCC Meeting

It was agreed that the 2nd JCC meeting would be given in February 2020.

Annex 1: The agenda of the 1st JCC
Annex 2: The list of participants
Annex 3: Content of the Presentation

Appendix 2-6: Minutes of 2nd JCC meeting

MINUTES OF MEETING
OF
2nd JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR IMPROVEMENT OF TECHNICAL EDUCATION FOR INDUSTRIAL HUMAN RESOURCES DEVELOPMENT

IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

The 2nd Joint Coordinating Committee (JCC) meeting on the Project for Improvement of Technical Education for Industrial Human Resources Development (hereinafter referred to as "the Project") was held on 5th April 2021, chaired by Mr. Md. Helal Uddin ndc, Director General of Directorate of Technical Education (DTE), Technical and Madrasah Education Division, Ministry of Education, at Zoom Online Platform.

As the result of discussions, participants agreed on the issues in the documents attached hereto.

15.04.2021

Takeshi Saheki	Md. Helal Uddin ndc
Senior Representative	Director General (Additional Secretary)
Japan International Cooperation Agency	Directorate of Technical Education
Bangladesh office	Technical and Madrasah Education Division
	Ministry of Education

The Attached Document

Discussion Points:

1. Report on Activities from September 2019 to January 2021

   1-1 Progress of Activities from September 2019 to January 2021

   - Regarding the progress of the activities, the Deputy Secretary of ERD raised a question that how it would be reflected in the TAPP since the TAPP was not officially approved. Also, the Planning Commission strongly encouraged to do all the activity within the TAPP time frame. The Chairperson stressed that the project was started based on the Record of Discussion which was signed in 2017 and the TAPP which reflected the suggestion given by the PEC meeting was already submitted to the Planning Commission for their final approval.
   - Regarding the implementation period, the Additional Secretary of TMED wanted to know the project period. The Chairperson informed that the project period was February 2019-February 2024 for 5 years and divided into two phases.
   - Regarding the approval of the TAPP, the Senior Representative of JICA Bangladesh Office requested DTE to follow up on the approval of the TAPP. At his request, the Additional Secretary of DTE instructed Mr. Jahangir Alam, the Director of Planning and Development of DTE, to obtain the approval of the TAPP as soon as possible.
   - He also mentioned that lecturers of the pilot polytechnic institutes should fully utilize the learning of the TOT.
   - Regarding the employment rate of Dhaka Polytechnic Institute, the principal argued that it should be reassessed to find out the real information.

   1-2 List of Equipment Provided by JICA

   - Regarding the list of equipment provided by JICA, the Principal of TTTC asked if there would be any plan to provide other equipment based on the list that TTTC submitted. The Chairperson and the Deputy Chief Adviser of the project informed that other equipment would be provided by another JICA project subject to the approval of the project.
   - Regarding the equipment provided by JICA, the Senior Representative of JICA requested to make a proper operation and maintenance of the equipment.

2. Planned activities from February 2021 to July 2021
   - Regarding the training of trainers (TOT), one remote TOT of each subject will be conducted by utilizing a learning management system.
   - Regarding the job placement activities, the project team provided detailed information including questionnaire survey to evaluate the satisfaction level of companies who hired graduates of DPI and DMPI, recruitment seminars, internship program, creation of ex-students database, and Facebook page for the ex-students based on the developed database.
3. Target Numbers of the PDM Indicators
   - Regarding the target number of PDM indicators, the target and status of each indicator under the Output 1 to 4 as well as Overall Goal and Project Purpose stipulated in the PDM were confirmed.
4. 3rd JCC Meeting

   It was agreed that the 3rd JCC meeting will be given in August or September 2021.
5. During the meeting, participants had close discussions as above and agreed on the content of the presentation as given in Annex 3, Annex 4 and Annex 5.

Annex 1: The agenda of the 2nd JCC
Annex 2: The list of participants
Annex 3: JCC presentation
Annex 4: The list of equipment provided by JICA
Annex 5: The target number of PDM indicators

Appendix 2-7: Minutes of 3rd JCC meeting

MINUTES OF MEETING
OF
3rd JOINT COORDINATING COMMITTEE
ON
THE PROJECT FOR IMPROVEMENT OF TECHNICAL EDUCATION FOR INDUSTRIAL HUMAN RESOURCES DEVELOPMENT

IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

The 3rd Joint Coordinating Committee (hereinafter referred to as "JCC") meeting for the Project for Improvement of Technical Education for Industrial Human Resources Development (hereinafter referred to as "the Project") was held on 2nd November 2021, chaired by Dr. Md. Helal Uddin, ndc, Additional Secretary of Technical and Madrasah Education Division, and Director General of Directorate of Technical Education (DTE), Technical and Madrasah Education Division, Ministry of Education, at Dhaka, People's Republic of Bangladesh.

As the result of discussions, participants agreed on the issues in the documents attached hereto.

Dhaka, 2 November 2021

Mr. Yusuke Mori
Chief Advisor
Project for Improvement
of Technical Education
for Industrial Human
Resources Development

Mr. Takashi Komori
Senior Representative,
Bangladesh Office,
Japan International
Cooperation Agency

Dr. Md. Helal Uddin, ndc
Additional Secretary,
Technical and Madrasah
Education Division and
Director General,
Directorate of Technical
Education,
Technical and Madrasah
Education Division,
Ministry of Education

The Attached Document

The 3rd JCC meeting was given according to the agenda as shown in Annex 1. JCC presentation was given in Annex 2. All documents were also distributed to all participants.
During the meeting, participants had close discussions as below and agreed on the contents of the presentation.

Main Points Discussed:

1. Report on Activities from September 2020 to September 2021
    - Regarding the progress of the activities, the Deputy Chief (Deputy Secretary) of Socio Economic Infrastructure Division (SEID), Planning Commission, Education Wing, raised a question about the main difference between KOSEN educational methodology and technical education methodology in Bangladesh. The Chief Adviser of the project explained that KOSEN educational methodology places an emphasis on research, which is required by the industry in Japan, as a result, the rate of employment of graduates is very high. The number of the students who proceed to university is also high. Therefore, the project is trying to apply teaching method learnt from KOSEN educational methodology in the pilot polytechnic institutes. The Chairperson also informed that the technical education system in Bangladesh is going to be developed based on the industry needs.

2. Planned Activities from July 2021 to June 2022
    - Regarding the planned activities, the Deputy Chief (Deputy Secretary) of SEID, Planning Commission, Education Wing, raised a question if there was any objective of this project to introduce the KOSEN system to Bangladesh. The Project Director of the Project replied that this project did not aim to copy the KOSEN system but introducing some of KOSEN education methodologies will improve teachers' capacity on how to conduct the practical classes, which will enhance the skills of students and make it possible for them to get a job easily in the industry.

3. Discussion on the Pilot Polytechnic Institute Outside of Dhaka
    - The Deputy Chief (Deputy Secretary) of SEID, Planning Commission, Education Wing, raised a question about the ranges of target students. The Project Director, Mr. Jahangir Alam, explained that two polytechnic institutes were selected as pilot institutes and students from these institutes have been engaged in the project.
    - The Chairperson mentioned that another pilot polytechnic institute located outside of Dhaka, Cox Bazar Polytechnic Institute, was also selected as a pilot institute for the 2nd half of the project.

Annex 1: The agenda of the 3rd JCC
Annex 2: JCC Presentation
Annex 3: The list of participants