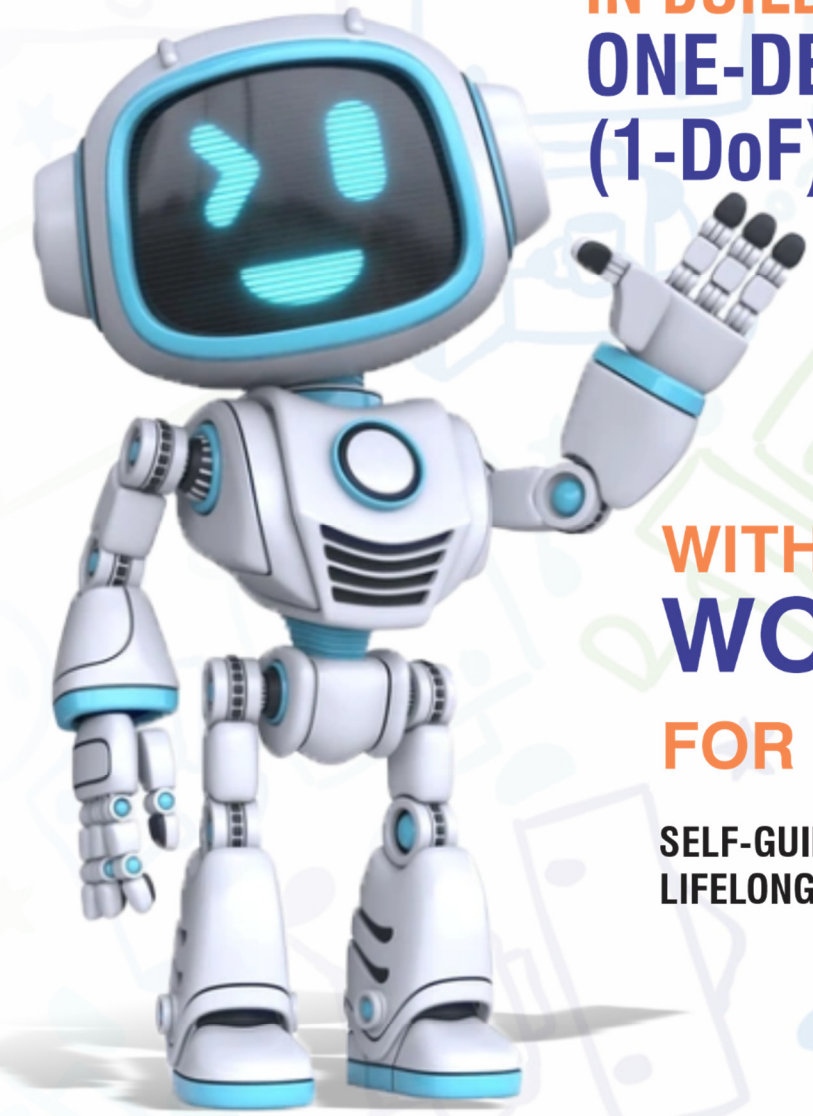
TREHS LIFELONG SUCCESS (TLS)



IN BUILDING ONE-DEGREE-OF-FREEDOM (1-DoF) ROBOTS

WITH WORKBOOK FOR STAGE 1

SELF-GUIDED LEARNER-CENTRED MODULE FOR LIFELONG SUCCESS WITH MULTIMEDIA CONTENTS

TREHS-24 (PRINT VERSION) 2ND EDITION

TREHS LIFELONG SUCCESS (TLS)

in Building

One-Degree-of-Freedom (1-DoF) Robots

with Workbook

for

Stage 1

SELF-GUIDED LEARNER-CENTRED MODULE FOR LIFELONG SUCCESS WITH MULTIMEDIA CONTENTS

TREHS-24 (PRINT VERSION) – 2ND EDITION

Introduction

This material is fundamental to building any robot from scratch. It is presented in the lowest form of comprehension for even primary one pupils. It contains exercises and practical work.

Subject Competencies

The learners will be able to build robots based on the necessity of the required Degree-of-Freedom.

Subject Objectives

To give fundamentals for robot building and to build One-Degree-of-Freedom Robots.

Working Through this Subject

Study through all the sections by fully carrying out recommended exercises and reading other available multimedia contents

Presentation Schedule

The contents are presented in themes and each theme is given in units. The book has both the manual and workbook together. The manual is at the front section while the workbook is towards the end of the book.

Assessment

- Classwork
- Group work
- Presentation
- Homework
- Quizzes
- Project work
- Tests
- Examination

How to Get the Most from the Subject

Explore all the available contents in different media

Learner Support

TREHS-24 has an electronic version to complement the print version with audio, video, and other multimedia contents

Subject Information

Status: Optional

Subject Blurb: The Anatomy of Transformative Artificial Intelligence and Robotics (AIR) for National Development

Class: 1-DoF Robot Building – Stage 1

Term: First, Second, and Third (Mostly for STEM Activities)

Subject Duration: For a minimum of a term and a maximum of a session

Required Hours for Study: Between 6 to 12 hours

Subject Team

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Contents

Preface

To the Custodian of wisdom, the One who is wisdom personified, be all the glory for His goodness and mercy.

To Him who gave the vision of the Christ The Redeemer's Schools to our amiable parents; Pastor E.A. Adeboye and Pastor Folu Adeboye, we ascribe all majesty.

Indeed, the world is moving at a speed likened to that of a jet. Here we find ourselves discussing artificial intelligence and more.

It is to this end, that the Redeemer's High School, Minna, Niger State, Nigeria has come to do justice to materials that will enhance learning for her students and by extension students in Nigeria and beyond.

These self-guided, learner-centred learning materials have been designed for life long success of students. They are with multimedia contents and also applicable to daily living. The materials are presented in the lowest form of comprehension such that Basic One pupils should be able to relate.

The One - Degree - Freedom (1-DoF) is highly recommended for pupils and students who do not want to lag in the growth of the world around them.

Pastor (Mrs.) Ibiyinka Olutunmbi
Chairperson, RCCG Region 41 Education Committee

Theme One

Introduction to Robots

Unit 1: Meaning of Robot

Unit 2: Examples of Robots in Daily Life

Unit 1

Meaning of Robot

1.0 Introduction

This unit will introduce you to the meaning of a robot. You will also learn what robots can do.

2.0 Behavioural Learning Outcomes (BLO)

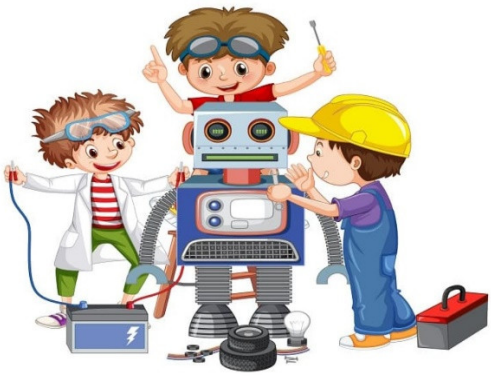
At the end of this unit, you should be able to:

i. Define a robot.
ii. List three (3) tasks robots can perform.

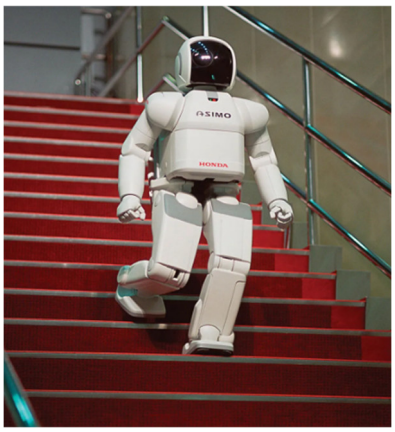
3.0 Main Content

3.1 Definition of a Robot

A robot is a machine that does tasks without the help of a person. Some robots look like human beings while others do not look like human beings.



Playing Robot



Robot walking down the staircase

3.2 What can Robots do?

Robots can do many tasks or jobs to help human beings. They can help us in some of our daily activities like cleaning the house, carrying loads from one place to another, and other house chores. Robots can help companies.

Robots can also work in dangerous places where human beings cannot work or survive like contaminated or dusty environments. They can handle hazardous materials like harmful chemicals or waste. Robots are also used in the educational sector to assist teachers and learners.

4.0 Multimedia Content

4.1 Audio Content (AC)

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4.2 Video Content (VC)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

4.3 Digital Learning Aids (DLA)

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4.4 Virtual Laboratory and Experiments (VLE)

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4.5 Virtual and Augmented Reality (VAR)

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5.0 Significance of the Unit

This unit will benefit you because you have understood the meaning of robots. Also, you know what robots can do for human beings. This has given you foundational knowledge about robots. It has also helped you to view other areas where robots can be useful in our daily activities.

6.0 Self-Assessment Activities (SAA)

Imagine other areas and aspects in which robots can help human beings.

7.0 Tutor-Marked Essay Questions (TMEQ)

1. What is a robot?
2. Mention three things that robots can do.

8.0 Tutor-Marked Objective Questions (TMOQ)

1. Robots are human beings. (Yes or No)
2. Robots can also work in dangerous places where humans cannot work or survive. (Yes or No)

9.0 Conclusion

In this unit, you have learnt about what a robot is and what robots can do. In the next unit, you will learn about examples of robots in our daily lives.

10.0 Summary

A robot (either human-like or non-human-like) is a machine that performs tasks without the help of a human being.

Robots can help in homes and companies, they can carry loads, they are useful in dangerous places and are also available in education for teaching and learning and so on.

11.0 References/Further Readings

https://kids.britannica.com/kids/article/robot/353723

https://www.google.com/search?q=a+robot+picture+for+kids&oq=a+robot+picture+for+kids&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigATIHCAQQIRifBTIHCAUQIRifBTIHCAYQIRifBTIHCAcQIRifBTIHCAgQIRifBTIHCAkQIRifBdIBCDcxNzFqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8

Unit 2

Examples of Robots in Daily Life

1.0 Introduction

In unit 1, you learnt about robots and what they can do for us. In this unit, you are going to learn about examples of robots in our daily lives. Robots are becoming an increasing part of our daily lives.

2.0 Behavioural Learning Outcomes (BLO):

At the end of this unit, you should be able to:

i. Give five (5) examples of robots in our daily lives.

ii. Describe what daily life robots can do.

3.0 Main Content

3.1 Educational Robots

Educational Robots are used in schools to teach subjects like Coding, Mathematics and Science. An example of an educational robot is **Bee-Bot.** A Bee-Bot is a small robot designed to help children learn basic programming.

Bet-Bots

3.2 Toy Robots

Toy Robots are robots that can walk, talk, or perform tricks. They are used for fun and learning. They can be referred to as robotic pets. Examples of toy robots are FurReal Friends.

FurReal Friends Robots

3.3 Vacuum Cleaner Robots

Vacuum cleaner robots are small, disc-shaped robots that move around the house cleaning the floors. A popular example is called Roomba.

Vacuum cleaner robot

3.4 Kitchen Robots

Kitchen robots are robotic appliances that help with cooking by performing repetitive tasks. Examples are bread-making machines, robotic arms for food preparation and pizza-making.

Kitchen robotic arms

Two kitchen robotic arms preparing food

One kitchen robotic arm turns food

Human-like robot serving food

3.5 Healthcare Robots

Healthcare robots are the robots that help doctors and nurses in hospitals. Examples of such robots are - Robotic Surgery Assistants, Medication Delivery Robots, Diagnosis Assistant Robots, etc.

Four healthcare robotic arms for surgery

Healthcare robot for hospital cleaning

Healthcare robot for medication delivery

Healthcare robot for care service to elders

4.0 Multimedia Content

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5.0 Significance of the Unit

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6.0 Self-Assessment Activities (SAA)

Imagine other areas where robots can render assistance in hospitals

7.0 Tutor-Marked Essay Questions (TMEQ)

1. Mention three healthcare robots
2. Give three (3) functions of the three healthcare robots mentioned.

8.0 Tutor-Marked Objective Questions (TMOQ)

1. What are the robots that are used in schools to teach? (A) Healthcare robots (B) Kitchen robots (C) Toy robots (D) Educational robots.
2. ..... are robots that can walk, talk, or perform tricks, often used for fun and learning. (A) Healthcare robots (B) Kitchen robots (C) Toy robots (D) Educational robots.

9.0 Conclusion

In this unit, you have learnt about some examples of robots in daily life. In the next unit, you will learn about the meaning of Degree-of-Freedom as it relates to the movement of robots.

10.0 Summary

In this unit, you have learnt about some examples of robots in daily life. They are:

i. Educational robots
ii. Toy robots
iii. Vacuum cleaner robots
iv. Kitchen robots
v. Healthcare robots

11.0 References/Further Readings

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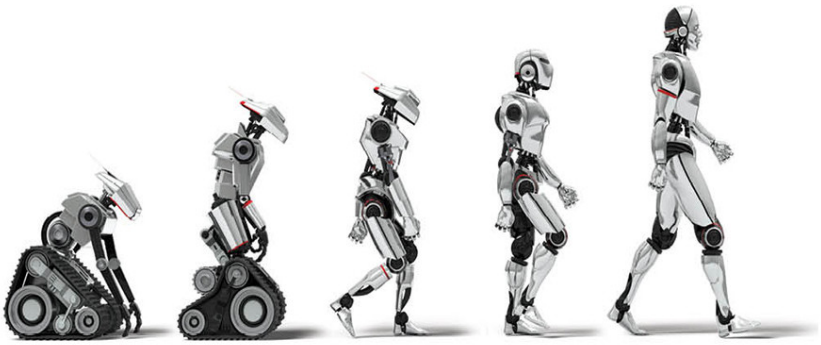
Theme Two

What is One-Degree-of-Freedom (1-doF)?

Unit 3: What does “Degree-of-Freedom mean?

Unit 4: Examples of 1-DoF in the real world



Unit 3

What Does “Degree-of-Freedom” Mean?

1.0 Introduction

In Unit 2, you learnt about examples of robots in daily life. In this Unit, you will learn about the Degree-of-Freedom as it relates to the movement of robots.

2.0 Behavioural Learning Outcomes (BLO)

At the end of this unit, you should be able to:

i. Define Degree-of-Freedom

ii. Give examples of Degree-of-Freedom

3.0 Main Content

3.1 Meaning of Degree-of-Freedom (DoF)

A Degree-of-Freedom (DoF) refers to the number of independent ways a robot can move. Each Degree-of-Freedom is a specific type of movement or rotation a robot can make.

3.2 Examples of Degree-of-Freedom (DoF)

For example, if a robot can move forward and backwards, it has one Degree-of-Freedom. Also, if another robot can move upward and downward, it has one Degree-of-Freedom. Another robot that can rotate clockwise or anticlockwise also has one Degree-of-Freedom.

4.0 Multimedia Content

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5.0 Significance of the Unit

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6.0 Self-Assessment Activities (SAA)

Based on the examples of Degree-of-Freedom mentioned in this unit, demonstrate any of them to your friends in the class.

7.0 Tutor-Marked Essay Questions (TMEQ)

1. What is the meaning of Degree-of-Freedom?
2. Give one example of One-Degree-of-Freedom.

8.0 Tutor-Marked Objective Questions (TMOQ)

1. Jumping up and down has one Degree-of-Freedom. (Yes or No)
2. How many Degree-of-Freedom are there in a robot's clockwise and anticlockwise movement? (A) 4 (B) 2 (C) 1 (D) 3

9.0 Conclusion

In this Unit, you have learnt the meaning of Degree-of-Freedom with its examples. In Unit 4, you will learn more about One-Degree-of-Freedom relating to real-life world examples.

10.0 Summary

A Degree-of-Freedom (DoF) refers to the number of independent ways a robot can move. Each of the following movements constitutes One-Degree-of-Freedom: (1) Upward/Downward (2) Forward/Backward and (3) Clockwise/Anti-clockwise

11.0 References/Further Readings

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

Unit 4

Example of 1-DoF in the Real World

1.0 Introduction

In Unit 3, you learned about Degree-of-Freedom and some examples. In this Unit, you will learn about real-world examples of One-Degree-of-Freedom movements.

2.0 Behavioural Learning Outcomes (BLO)

At the end of this unit, you should be able to:

i. Give three (3) examples of One-Degree-of-Freedom

ii. Relate One-Degree-of-Freedom to four (4) real-world movements

3.0 Main Content

3.1 Examples of One-Degree-of-Freedom: Forward and Backward

Forward and backward movement is One-Degree-of-Freedom in which a robot can only move forward and backwards.

In the real world, examples of forward and backward movement are:

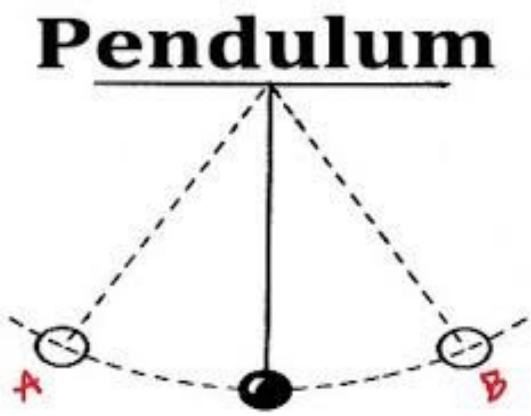
(i) A swing at a children's playground moves forward and backwards, therefore it has One-Degree-of-Freedom

A boy using a swing

A pair of swings

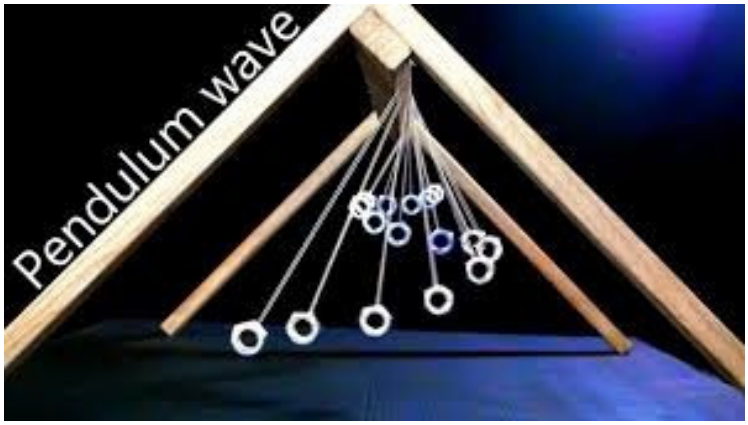
(ii) A pendulum shows forward and backward swinging movement which indicates One-Degree-of-Freedom

A clock with a pendulum



A pendulum swings from position A to B

An improvised pendulum



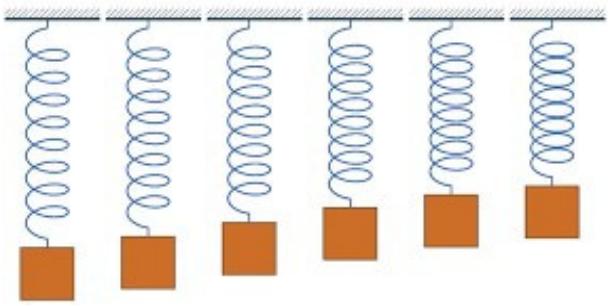
A set of pendulum balls to generate pendulum waves

(iii) A door swinging forward and backwards is an example of One-Degree-of-Freedom robot

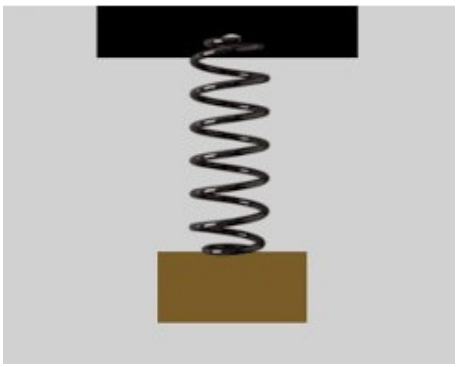
One swinging door

A pair of swinging doors

3.2 Examples of One-Degree-of-Freedom: Upward and Downward



A set of 5 springs with loads



A spring

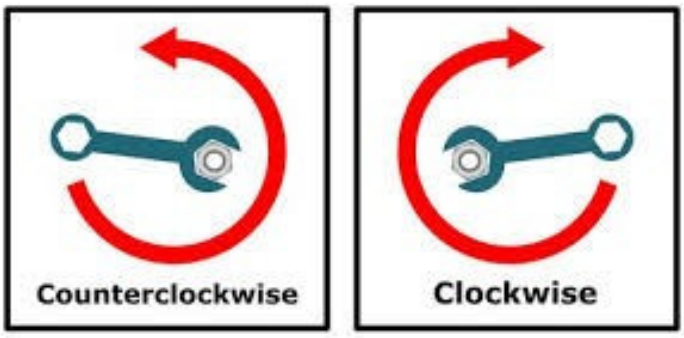
A jumping child

A jumping child

3.3 Examples of One-Degree-of-Freedom: Clockwise and Anticlockwise

A clock

A rotating fan



Spanners and nuts

A vehicle wheel

4.0 Multimedia Content

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5.0 Significance of the Unit

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6.0 Self-Assessment Activities (SAA)

You can look around you and observe any One-Degree-of-Free movement in the various real-life objects

7.0 Tutor-Marked Essay Questions (TMEQ)

i. Mention three examples of One-Degree-of-Freedom

ii. A swing is under which example of Degree-of-Freedom?

8.0 Tutor-Marked Objective Questions (TMOQ)

1. Which object observes upward and downward Degree-of-Freedom? (A) A swing (B) A door (C) A spring (D) A fan
2. Which of the following is not clockwise and anticlockwise Degree-of-Freedom? (A) A spanner and nut (B) A vehicle wheel (C) A fan (D) A jumping child

9.0 Conclusion

In this unit, you have learnt about the examples of One-Degree-of-Freedom in three different forms. You also learnt the real-world examples of these forms. In Unit 5, you will enter into the section where you will build simple One-Degree-of-Freedom Robots. Particularly, you will be learning how to build a simple pendulum bot.

10.0 Summary

The three forms of One-Degree-of-Freedom that you learnt are:

i. Forward and backward
ii. Upward and downward
iii. Clockwise and anticlockwise
iv. Under each form, you learnt the real-world examples.

11.0 References/Further Readings

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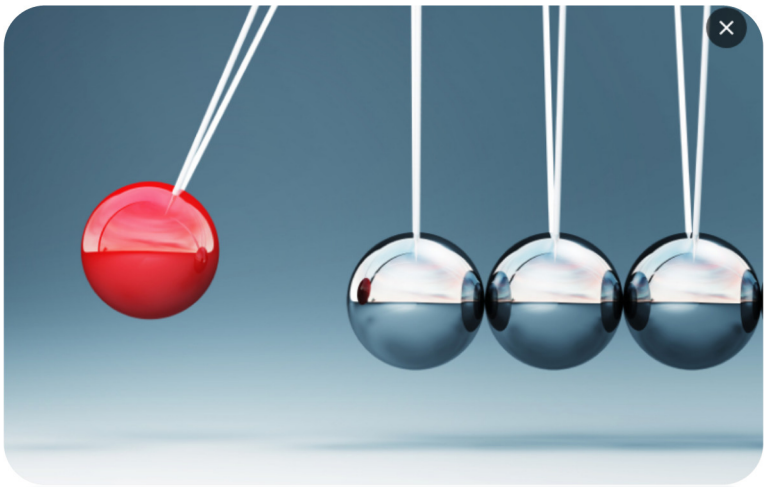
Theme Three

Building Simple One-Degree-of-Freedom Robot

Unit 5: **Project 1:** Rolling and Coupled Pendulums Experiments

Unit 6: **Project 2:** A Robotic Arm



Unit 5

Project 1: Rolling and Coupled Pendulum Experiments

1.0 Introduction

In Unit 4, you learned about the different forms of One-Degree-of-Freedom in the real world, which included pendulum movement. In this unit, you will learn how to use locally available materials to build rolling pendulums and coupled pendulums.

2.0 Behavioural Learning Outcomes (BLO)

At the end of this unit, you should be able to:

i. Build a rolling pendulum

ii. Build coupled pendulums

3.0 Main Content

3.1 Building of a Rolling Pendulum

A rolling pendulum is a pendulum that combines a rolling motion and a swinging motion together. In the next section, the materials you will need to build a rolling pendulum and procedures to follow have been listed.

3.1.1 Materials Needed for Building a Rolling Pendulum

The materials needed to build a rolling pendulum are:

1. **Hard cardboard or empty carton:** For the pendulum shaft structure, stands, base and two weights.
2. **Short stick:** To suspend the pendulum.
3. **Tape or glue or gum:** To secure parts together.
4. **Scissors:** For cutting the cardboard.
5. **Ruler:** For measurement
6. **Markers or crayons:** For decorating the pendulum.

3.1.2 Activities and procedures for building a rolling pendulum

1. Design the Pendulum:
2. Attach the Parts Together:
3. Create the Suspension Point:
4. Setup the Pendulum:
5. Decorate:
6. Demonstrate and Experiment:

3.2 Building of Coupled Pendulums

Coupled pendulums are a system of two or more pendulums that are connected in such a way that they can influence each other's motion. In the next section, the materials you will need to build coupled pendulums and procedures to follow have been listed.

3.2.1 Materials needed for building coupled pendulums

1. **Two small, lightweight objects:** Such as small nuts of a bolt or washers or toys.
2. **Two strings:** Each about 20-30 cm long.
3. **A horizontal rod or bar:** This can be a broomstick or a sturdy piece of cardboard.
4. Connecting string or ribbon: About 15-20 cm long.
5. **Support structure:** Two chairs or a frame to hold the horizontal rod.
6. **Tape or glue:** To secure parts if needed.
7. **Scissors:** For cutting strings.
8. **Markers or stickers:** For decorating the pendulums.

3.2.2 Activities and procedures for building coupled pendulums

1. Prepare the Pendulums
2. Setup the Horizontal Rod
3. Attach the Pendulums
4. Couple the Pendulums
5. Decorate the Pendulums
6. Test the Coupled Pendulums
7. Experiment and Observe

4.0 Multimedia Content

4.1 Audio Content (AC)

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5.0 Significance of the Unit

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6.0 Self-Assessment Activities (SAA)

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7.0 Tutor-Marked Essay Questions (TMEQ)

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8.0 Tutor-Marked Objective Questions (TMOQ)

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9.0 Conclusion

In this unit, you have been practically empowered to build your One-Degree-Freedom robots using locally available materials. In Unit 6, the last unit for the Stage 1 book, you will learn how to build a robotic arm of One-Degree-of-Freedom.

10.0 Summary

You have learned how to build rolling pendulums and coupled pendulums.

Steps for building a rolling pendulum

1. Design the Pendulum
2. Attach the Parts Together

3. Create the Suspension Point
4. Setup the Pendulum
5. Decorate
6. Demonstrate and Experiment

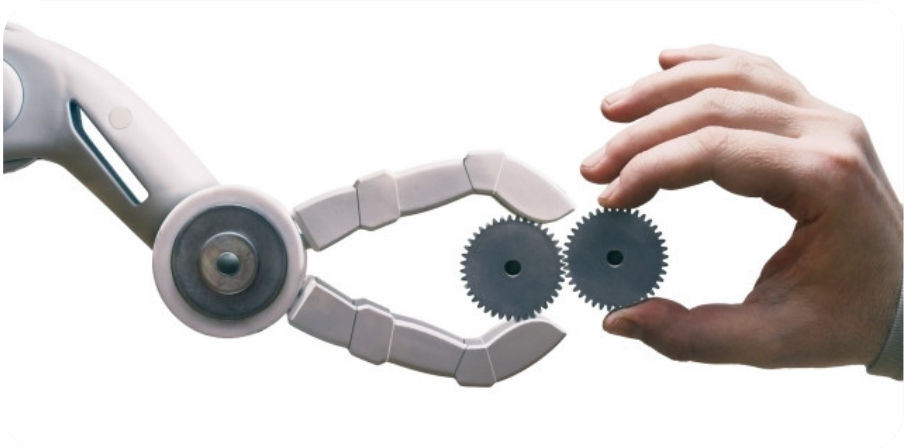
Steps for building coupled pendulums

1. Prepare the Pendulums
2. Setup the Horizontal Rod
3. Attach the Pendulums
4. Couple the Pendulums
5. Decorate the Pendulums
6. Test the Coupled Pendulums
7. Experiment and Observe

11.0 References/Further Readings

Rolling pendulum experiment:
https://www.youtube.com/watch?v=K1bNHNttWoo

Coupled pendulums experiment
https://www.youtube.com/watch?v=WFy-TCWtWkQ



Unit 6

Project 2: A Robotic Arm

1.0 Introduction

In Unit 5, you learned how to build rolling and coupled pendulums as examples of 1-DoF. In Unit 6, you will learn how to build a 1-DoF robotic arm.

2.0 Behavioural Learning Outcomes (BLO)

At the end of this unit, you should be able to:

i. Build a 1-DoF robotic arm using locally available materials

ii. Use the robotic arm to pick an object

3.0 Main Content

3.1 Building of 1-DoF robotic arm

The 1-DoF robotic arm is the one that can move only in One-Degree-of-Freedom to pick an object.

3.1.1 Materials needed for building 1-DoF robotic arm

1. One cardboard paper
2. Double-sided tape
3. Thread and long stick or broomstick
4. Drinking straw
5. Scissors
6. Pencil

3.1.2 Activities and procedures for building 1-DoF robotic arm

1. Trace your hand on the cardboard and cut it out
2. Cut the straw about 1.5cm into 14 pieces
3. Cut the straw into 3 pieces of about 9cm and 2 pieces of about 7cm
4. Cut and stick double-sided tape on the cutout cardboard trace of your hand
5. Stick the straws
6. Cut and tie a thread (40cm) on the straw at the tip of the finger
7. Use a stick to insert the thread inside the straw easily
8. Repeat step 7 to all 5 fingers
9. Tie the threads together
10. Insert in a straw and play!

3.2 Picking an object using the built robotic arm

After building your robotic arm, you can then use it to pick an object.

4.0 Multimedia Content

4.1 Audio Content (AC)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

4.2 Video Content (VC)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

4.3 Digital Learning Aids (DLA)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

4.4 Virtual Laboratory and Experiments (VLE)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

4.5 Virtual and Augmented Reality (VAR)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

5.0 Significance of the Unit

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

6.0 Self-Assessment Activities (SAA)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

7.0 Tutor-Marked Essay Questions (TMEQ)

Contact TREHS Entrepreneurship Centre, Visit TREHS YouTube Channel and other social media platforms

8.0 Tutor-Marked Objective Questions (TMOQ)

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9.0 Conclusion

In this unit, you have learned how to build a robotic arm. The next unit in TREHS-24 in Robots Building is the first unit in TREHS Lifelong Success (TLS) in Building Two-Degree-of-Freedom (2-DoF) Robots with Workbook for Primary 2.

10.0 Summary

In this unit, you have learnt:

i. Building of 1-DoF robotic arm using locally available materials

ii. Using the robotic arm to pick an object

11.0 References/Further Readings

One-Degree-of-Freedom Robotic Arm using Cardboard

https://www.youtube.com/watch?v=_-cTge2mZLs

TREHS LIFELONG SUCCESS (TLS)

in Building

One-Degree-of-Freedom (1-DoF) Robots

with Workbook

for

Stage 1

SELF-GUIDED LEARNER-CENTRED MODULE FOR LIFELONG SUCCESS WITH MULTIMEDIA CONTENTS

WORKBOOK

TREHS-24 (PRINT VERSION) 2ND EDITION

THEME ONE

INTRODUCTION TO ROBOTS

Unit 1: What is a robot and what can robots do?

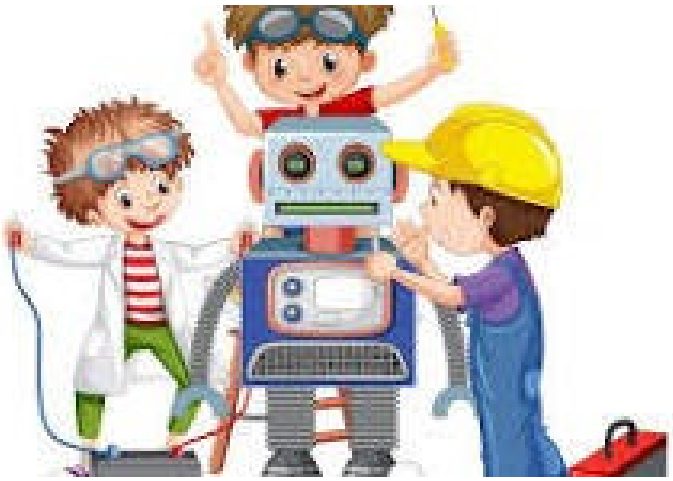
1. Define a robot

.....

.....

.....

2. What are the three pupils in the diagram below playing with?



3. Mention Four things that robots can do:

(i) .....

(ii) .....

(iii).....

(iv).....

Unit 2: Examples of robots in daily life

1. List Five examples of robots in our daily lives

(i) .....

(ii) .....

(iii).....

(iv).....

(v) .....

2. ..... robots are small, disc-shaped robots that move around the house cleaning the floors. A popular example is called Roomba.
3. Name the example of a robot depicted in the diagram below: .....

Unit 3: What does "Degree-of-Freedom" mean?

1. A Degree-of-Freedom (DoF) refers to.....

.....

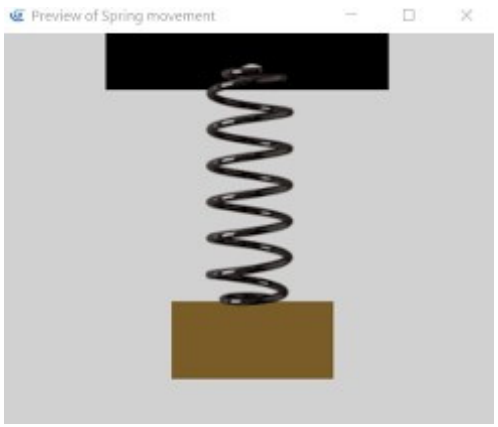
.....

2. If a robot can move forward and backwards, it has ..... Degree-of-Freedom.
3. A robot that can rotate clockwise or anticlockwise ..... Degree-of-Freedom.

Unit 4: Examples of 1-DoF in the real world

1. Forward and backward movement is One-Degree-of-Freedom in which a robot can only .....
   .....
2. The other two forms of One-Degree-of-Freedom are: .....
   .....
   and.....
3. Label the correct form of One-Degree-of-Freedom movement depicted in the diagrams below:

(i).....



(ii).....

(iii).....

(iv).....

Unit 5: Project 1: Rolling and Coupled Pendulums Experiments

1. List the materials used for rolling the pendulum:

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2. List the materials used for coupled pendulums:

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3. Mention the steps of building coupled pendulums:

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Unit 6: Project 2: A Robotic Arm

1. List the materials needed to build 1-DoF robotic arm:

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2. Mention the steps of building 1-DoF robotic arm:

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3. Mention two objects that the robotic arm can pick:

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APPRECIATION

All the subject development team members are well acknowledged and appreciated.

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