First edition

Systems Engineering

Units 1 and 2

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SE26-31 U1/2

Systems Engineering
Units 1 and 2

LAPtek

UNIT 1: ELECTROTECHNOLOGICAL SYSTEMS DESIGN

UNIT 2: MECHANICAL SYSTEMS DESIGN

LEARNING OUTCOME UNIT 1

Outcome 1	Electrotechnology system design and society
Outcome 2	Creating electrotechnological system design

LEARNING OUTCOME UNIT 2

Outcome 1	Evolution of mechanical systems design
Outcome 2	Creating mechanical systems

Student Learning Guide & Record – Unit 1

TASK	Page	TASK TITLE	DATE COMPLETED	TEACHER'S SIGNATURE
Task 1	9	Investigate electrotechnological systems design and society		
Task 2	14	Summarise electrons and matter		
Task 3	18	What is electricity		
Task 4	23	OHM's law, switching and circuits		
Task 5	26	Voltage drop		
Task 6	31	Parallel circuits		
Task 7	39	Types of switches		
Task 8	44	Semiconductors		
Task 9	47	Solenoid and relays		
Task 10	51	Producing alternating current, sine wave and other wave forms		
Task 11	55	Producing direct current		
Task 12	57	Transformers		
Task 13	61	Capacitors		
Task 14	66	Resistance values		
Task 15	72	Batteries		
Task 16	74	Make your PCB (optional)		
Task 17	74	Check all components (optional)		
Task 18	81	Review questions for power and energy		
Task 19	84	Summarise photovoltaic cells		
Task 20	85	Identify common circuit symbols		
Task 21	86	Identify uses for microcontrollers		
Task 22	93	Turn led connected to pin 13 'ON'		
Task 23	94	Turn led connected to pin 13 'OFF'		
Task 24	94	Make the led connected to pin 13 'BLINK'		
Task 25	95	Change the 'BLINK' rate		
Task 26	96	Using the breadboard		
Task 27	97	Change the input to pin 6 and rewrite the program		
Task 28	98	Add two more LED's to the breadboard and make them blink		
Task 29	99	Change the blink programming sequence		
Task 30	99	Add variables		
Task 31	101	Change the 'int' variable		
Task 32	101	Write a new program using the 'int' variable		
Task 33	102	Read the changing resistance of a LDR		
Task 34	103	Use two LED's to indicate light intensity		
Task 35	106	Setting a servo to zero		
Task 36	107	Setting the servo angle from the serial monitor		
Task 37	110	Joystick operation		
Task 38	111	Using the joystick to control servos		
Task 39	115	Graphically explain how a H-bridge works		
Task 40	115	Control direction and speed of a DC motor		
Task 41	117	Control direction and speed of two (2) DC motors		
Task 42	118	Control direction and speed of two (2) DC motors		
Task 43	120	Using a LCD display		
Task 44	121	Add a second message to the LCD display		
Taak 45	122	Use the second line of the lcd display		
Task 46	122	Make additional changes to the program		

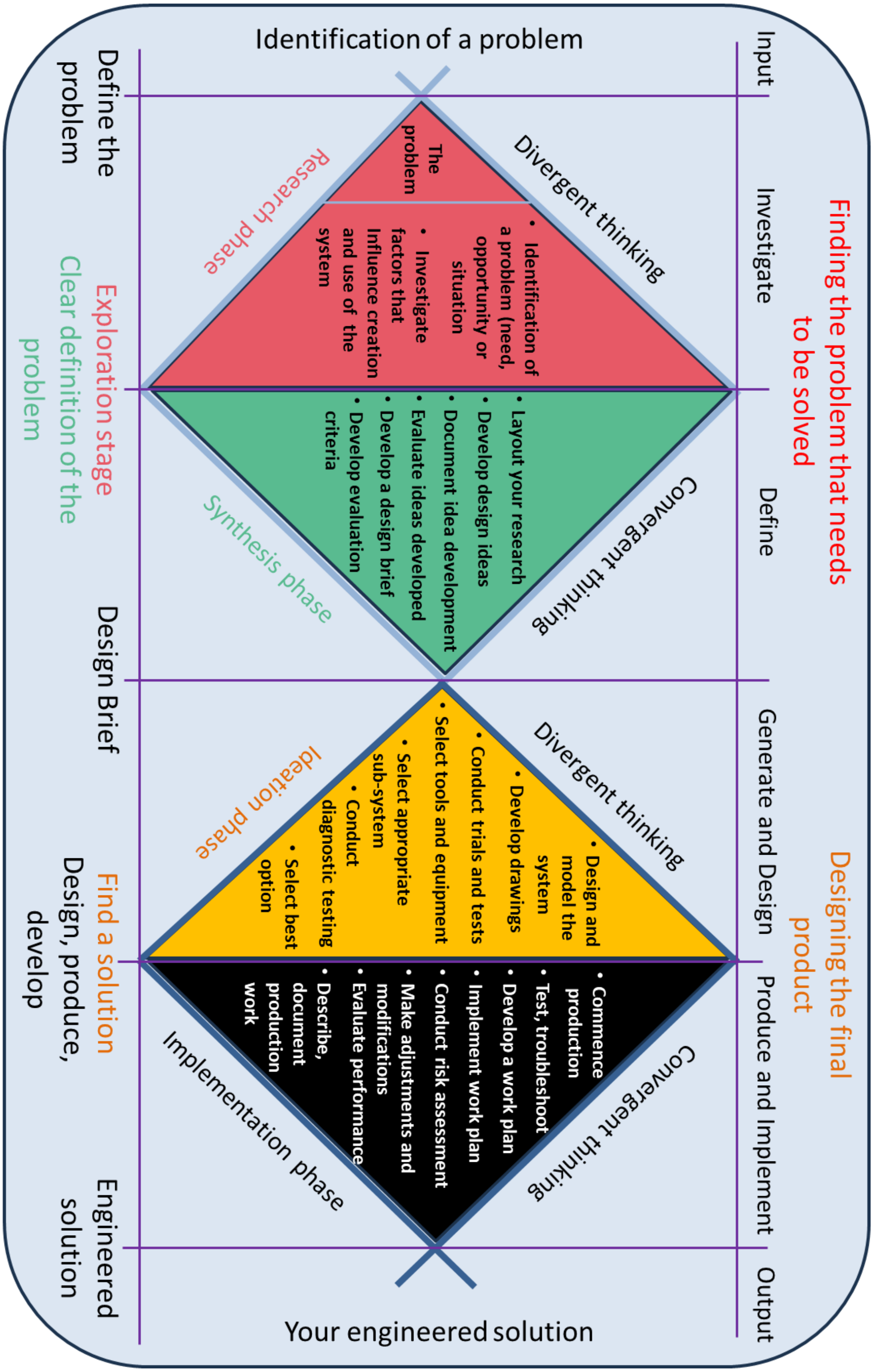
Student Learning Guide & Record – Unit 2

TASK	Page	TASK TITLE	DATE COMPLETED	TEACHER'S SIGNATURE
Task 1	200	Explain the evolution of mechanical systems		
Task 2	206	Energy		
Task 3	209	Draw a block diagram		
Task 4	217	Exercise – Law of the lever		
Task 5	223	Exercises – Pulleys		
Task 6	225	Exercises – Wheel and axle		
Task 7	229	Exercises – Inclined plane, wedge and screws		
Task 8	234	Exercises – Gears and gearboxes		
Task 9	237	Review questions - Friction		
Task 10	240	Belt drive and velocity ratio calculations		
Task 11	241	Speed calculation		
Task 12	242	Type of motion		
Task 13	243	Changing the direction of motion		
Task 14	246	Types of forces acting on a structure		
Task 15	249	Review questions		
Task 16	253	Hydraulic systems		
Task 17	255	Pascal's principle		
Task 18	257	Draw a system block diagram of your mechanical, electro-mechanical system		
Task 19	259	Control a unipolar stepper motor - Program 1		
Task 20	260	Change the parameters		
Task 21	261	Control a unipolar stepper motor - Program 2		
Task 22	261	Change the parameters		
Task 23	262	Control two unipolar stepper motors		
Task 24	263	Test pull-up resistor circuit		
Task 25	265	Test the tilt switch		
Task 26	266	Add LED's to the tilt switch		
Task 27	268	Identify uses for a tilt switch		
Task 28	269	Read a radio frequency identification tag		
Task 29	270	Record the RFID tag ID		
Task 30	271	Use a RFID tag to operate a servo		
Task 31	274	Explain how a water level detection sensor works		
Task 32	274	Observe resistance change		
Task 33	275	Make a rain detector		
Task 34	280	Write in the code for the following numbers		
Task 35	280	Write in the code for the following numbers		
Task 36	281	Display digital numbers 0 – 2 on a 7 segment LED display		
Task 37	283	Add the digital numbers 3, 4, 5, 6, 7, 8, 9 and 0		
Task 38	284	Display digital numbers 8 to test connections for a 4 digit LED display module		
Task 39	285	Display digital numbers 1 - 4		
Task 40	290	Identify common applications of temperature sensors		
Task 41	290	Add DHT sensor to library		
Task 42	291	Use a DHT11 temperature and humidity sensor		
Task 43	293	Explain how a Fresnel Lenz works		
Task 44	294	Use a HC-SR501 PIR sensor		

TASK	Page	TASK TITLE	DATE COMPLETED	TEACHER'S SIGNATURE
Taak 45	295	Change the sensitivity, time delay and mode		
Task 46	397	Use a capacitive touch sensor		
Task 47	300	Using relays to control the direction of a dc motor		
Task 48	301	Use a relay to turn a motor on		
Task 49	306	Make a line follower robot		
Task 50	309	Decide on a mechanical system that addresses a problem related to inclusive design to plan, design and produce		
Task 51	310	Carry out primary and secondary research		
Task 52	314	Review the research data		
Task 53	316	Write a clear and defined 'Design Brief'		
Task 54	318	Concept drawings		
Task 55	321	Design options		
Task 56	324	Draw preferred design option		
Task 57	325	Justification of preferred option		
Task 58	326	Evaluation criteria		
Task 59	327	Make a prototype model of your preferred design option		
Task 60	328	List of materials and components		
Task 61	329	Make a production plan		
Task 62	332	Carry out risk assessment		
Task 63	336	Commence making your system		
Task 64	336	Use measuring and/or test equipment		
Task 65	338	Carry out the measuring and testing		
Task 66	339	Perform basic calculations		
Task 67	340	Reflections		
Task 68	341	Design review/evaluation		
Task 69	343	Maintain a record of the production work (50+ words)		

DOUBLE DIAMOND DESIGN PROCESS

The Double Diamond design process is a cohesive framework and is used by you to devise creative solutions to complex problems. It is an outcome-based framework that encourages creativity and innovation while focusing on the core issues and the impact the solution has on all end users. It is an excellent approach for identifying a problem and developing a solution.



UNIT 1 ELECTROTECHNOLOGICAL SYSTEMS DESIGN

OUTCOME 2 – CREATING ELECTROTECHNOLOGICAL SYSTEMS DESIGN

This area of study involves you using the systems engineering process to produce controlled, operational electrotechnological systems that address a problem related to sustainability. You use materials, components, and manual and digital tools to produce systems, all while managing identified risks. You employ testing tools to diagnose system performance, making necessary modifications and adjustments to ensure each system effectively addresses identified sustainability issues. You develop an understanding of commonly used electrotechnological components, including their typical performance and form factors, implementation, and representation in schematic circuit diagrams and circuit simulation software. Progress is recorded, and both the systems and your use of the systems engineering process are evaluated, considering factors influencing system creation. You also propose ways to improve the systems and their use of the systems engineering process.

On completion of this unit, you should be able to use the systems engineering process to discuss and apply basic electrotechnological and control engineering concepts, principles and components to produce a system that addresses a sustainability problem and evaluate the system and their use of the systems engineering process. (VCAA Systems Engineering Study Design Page 31).

Some of the tools and equipment required for Systems Engineering

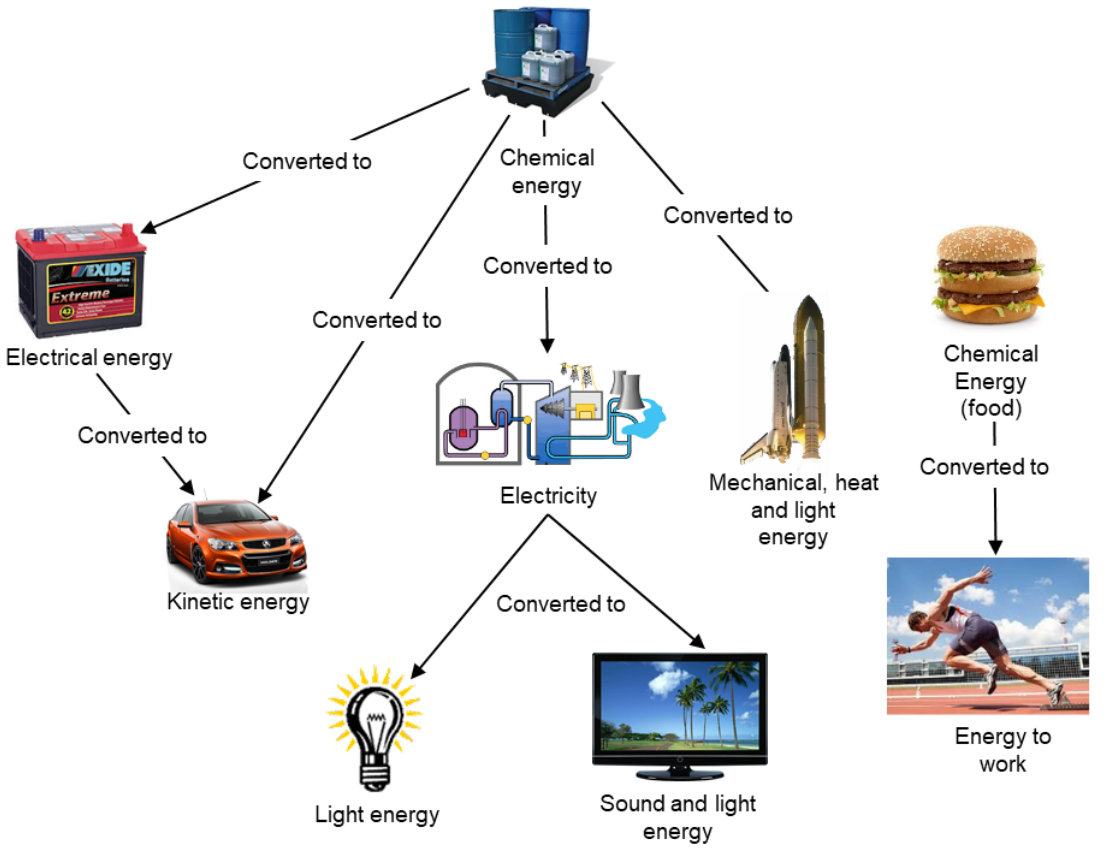
STARTING THE DESIGN PROCESS

The best time to commence the design process (pages 142 – 197) to produce a controlled, operational electrotechnological systems that addresses a problem related to sustainability is as early as possible, ideally during your selected project's research stages and then continue throughout the project's lifecycle with ongoing testing and iteration. Each iteration involves designing, constructing, testing and refining, and the process is repeated until success is achieved.

In an electrical circuit, heat is produced in the conductors connecting the source of electrical energy to the load. Heat is dissipated in the load as well. The amount of heat dissipated depends on the resistance of the conductors and the load.

ENERGY AND WORK

Electricity is a form of energy. Electrical energy is produced by converting other forms of energy, such as heat or mechanical energy. The electrical energy produced by this process is then consumed by the load that is connected to the source of electrical energy. This is illustrated in the picture below, which shows a power station supplying electrical energy to a house by way of overhead conductors. The various appliances inside the house connected to the electrical supply convert the electrical energy to heat, magnetic energy (motors) and other forms of energy.

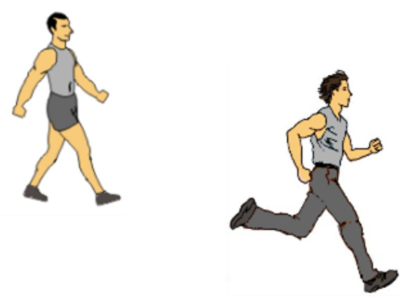


Energy is converted to other forms of energy

THE RELATIONSHIP BETWEEN WORK AND ENERGY

The relationship between work and energy can be explained with a human activity. Two men, of equal weight, are exercising during lunch. One man walks slowly and takes 20 minutes to walk a distance of 1 km. The other runs the 1 km distance and takes 5 minutes. Who did the most work? Who used the most amount of energy?

Both men have used the same amount of energy and have done the same amount of work. However, the runner has taken less time to do so compared to his companion.



If both people travel the same distance, who does the most work?

This raises the question of work and its relationship to the time taken to do the work. There must be a difference that explains why one person travelled the distance in a quarter of the time taken by the other.

The answer is power!

Solar array

Photovoltaic modules are connected to form an array. The term "array" refers to the entire generating plant, whether it is made up of one or several thousand modules. The larger the area of a module or array, the more electricity that will be produced. Photovoltaic modules and arrays produce direct-current (dc) electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

Solar array

TASK 19: SUMMARISE PHOTOVOLTAIC CELLS

How: Write a summary of 'Photovoltaic cells".

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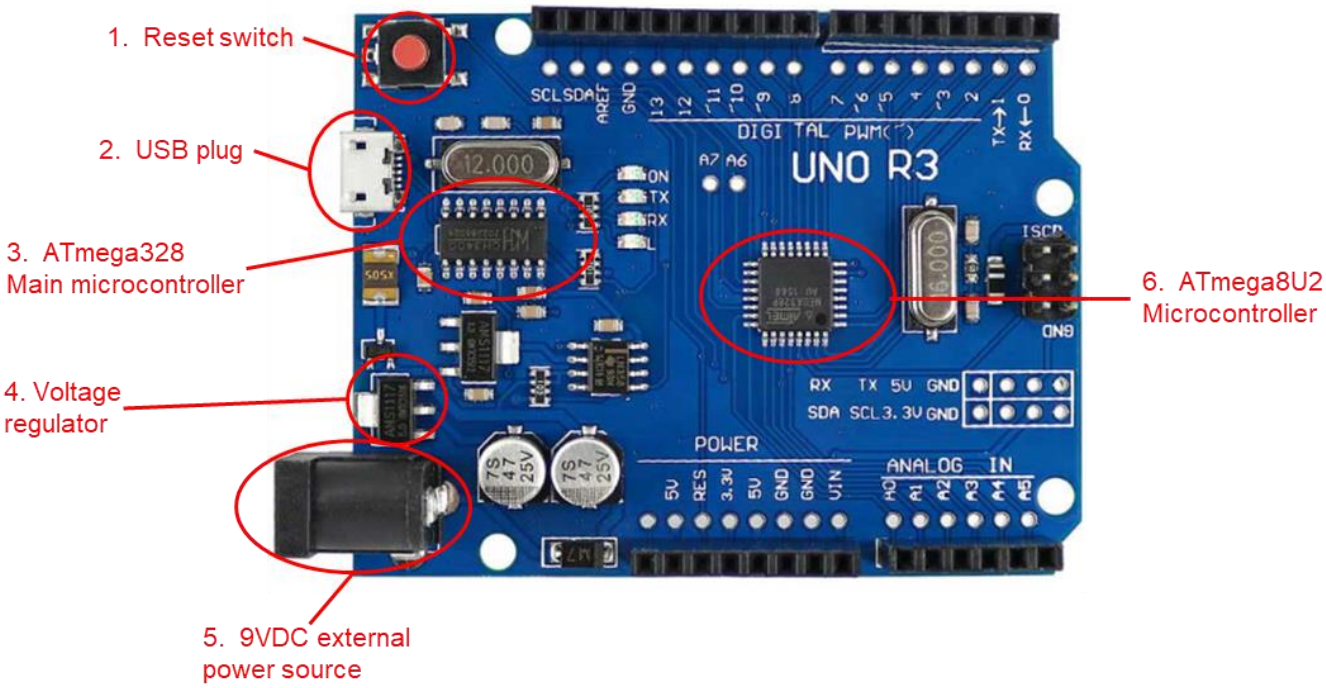
THE ARDUINO UNO

The Arduino UNO uses microcontrollers that are basically tiny computers. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button.

The Arduino UNO can run small, simple software programs that require very little power to operate and can be powered by a 9VDC battery for days. The Arduino UNO can process information faster than any human being can think.



Arduino UNO components

1. **Reset switch**
   The reset switch enables you to "reboot" your Arduino UNO.

2. **USB plug**
   The USB plug provides power to the Arduino UNO from the USB cable.

3. **ATmega328 Main microcontroller**
   The Arduino UNO uses a series of microcontrollers called ATMEGA AVRs.

4. **Voltage regulator**
   The voltage regulator reduces the voltage to 5VDC

5. **9VDC external power source**
   Allows you to attach a 9VDC power source so you can work independently from the computer.

6. **ATmega8U2 microcontroller**
   Uploads the software that you create to the main microcontroller. This chip is what lets you connect your USB cable to the Arduino board and communicate via the USB. It lets you upload your programs onto the main microcontroller, and once you have your program running, this chip is what allows you to send messages back and forth between your computer and your Arduino.

6 – 14 E Pin. The E pin enables the writing to the registers, or the next 8 data pins from D0 to D7. So through this pins we are sending the 8 bits data when we are writing to the registers or for example if we want to see the latter uppercase A on the display we will send 0100 0001 to the registers according to the ASCII table.

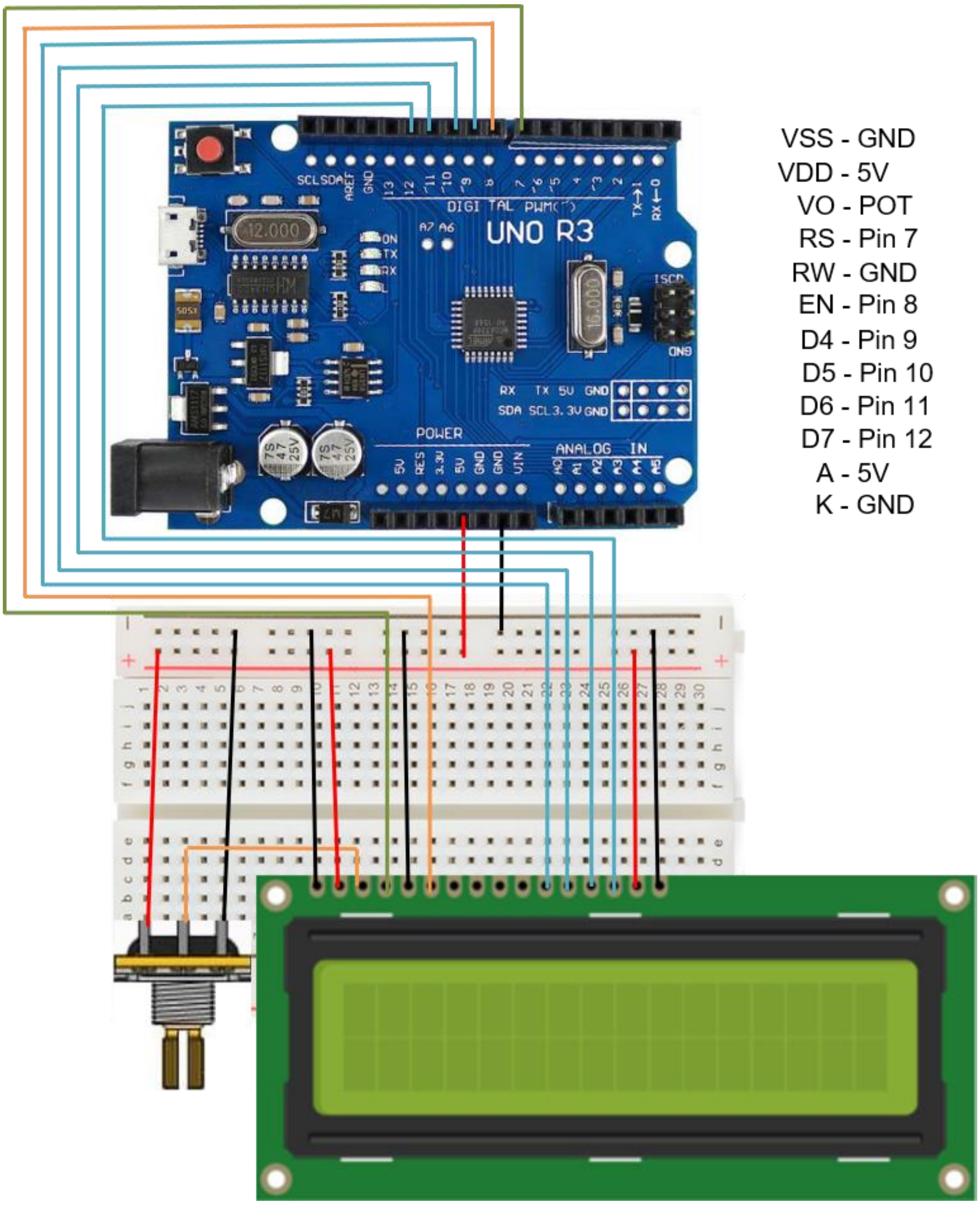
15 – 16 The last two pins A and K, or anode and cathode are for the LED back light.

TASK 43: USING A LCD DISPLAY

How: Connect and write information to a 2 x 16 Character back lit LCD display using the Arduino UNO.

1. Connect the LCD display and 5K potentiometer to the Arduino UNO, as per the following diagram.

2. Connect the Arduino to the Comm port and adjust the potentiometer until 16 rectangular blocks appear on the LCD screen. If the blocks do not appear recheck your connections.



VSS - GND
VDD - 5V
VO - POT
RS - Pin 7
RW - GND
EN - Pin 8
D4 - Pin 9
D5 - Pin 10
D6 - Pin 11
D7 - Pin 12
A - 5V
K - GND

Connections for LCD display and 5K potentiometer to an Arduino UNO

3. Type the following program into IDE.

THE DOUBLE DIAMOND DESIGN PROCESS

The Double Diamond design process is a cohesive framework and is used by you to devise creative solutions to complex problems. It is an outcome-based framework that encourages creativity and innovation while focusing on the core issues and the impact the solution has on all end users. It is an excellent approach for identifying a problem and developing a solution.

The design framework features two diamonds, the first diamond represents the problem and encourages you as the designer to identify the core issues and to truly understand the problem.

Once you have identified the core issues in the first diamond, you create a design brief that is used as a foundation for the second diamond.

The second diamond focuses on the solution to the problem identified in the design brief, where you create prototype models and test the solution until a successful outcome is achieved.

THE DOUBLE DIAMOND IN ACTION

Within the two diamonds are phases of divergent and convergent thinking. Together they make up four distinct steps. The four distinct steps are, Discover, Define, Develop and Deliver.

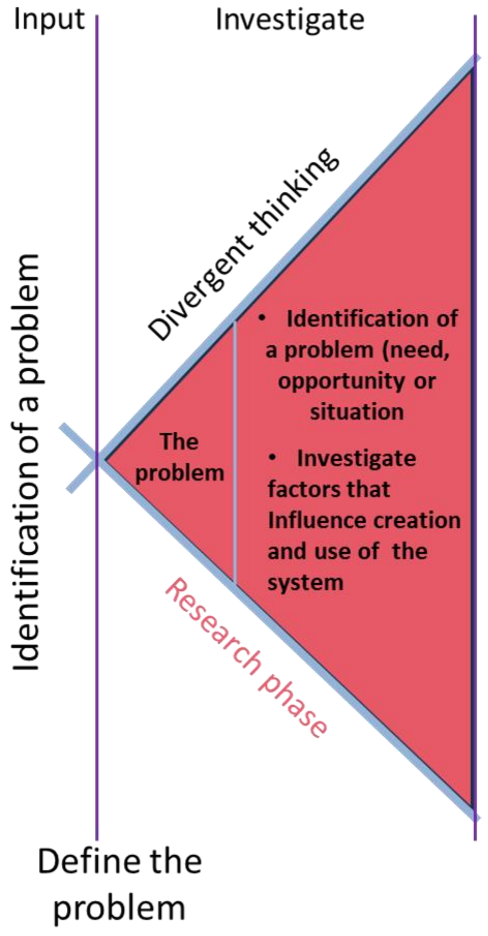
5. Discover

Divergent thinking phase. Divergent thinking is a thought process used to generate creative ideas by exploring many possible solutions.

The first step of the diamond utilises your divergent thinking skills, this phase is where you gain a sound understanding of the problem. Your understanding is gained by researching, observing, and empathizing with users. Your aim here is to gather insights into the problem and to identify opportunities to solve the problem. Key activities in Stage 1 include:

- Research.
- Identify a problem (need, opportunity or situation).
- Investigate factors that influence the creation and use of the system.
- Observations.
- Group work to generate ideas and share ideas.

It is very important for you to document your research findings, insights and key learnings in this stage, this ensures the information is accessible and actionable for the rest of the design process.



Phase 1 Discover

Primary and secondary research sources

Primary and secondary sources are the two useful tools used for research, and while both are important to creating well-developed projects, they are vastly different. Primary sources give direct access to the subject of the research, whereas secondary sources offer summaries, opinions and analysis of the information researched from primary sources.

1 DISCOVER:

TASK 60: CARRY OUT PRIMARY AND SECONDARY RESEARCH

How: Carry out primary and secondary research on your system that addresses a sustainability problem. You are not looking to solve the problem in this stage, you are simply trying to gain an understanding of the scale and complexity of designing and producing a system that addresses a sustainability problem.

Collect 6 images from books, magazines, photos, photocopy pages, library and the internet and paste them into Pages 150 - 152. Write annotations next to each image to explain why you collected the image and how it meets the design brief.

Write below a list of the resources you gained information from.

1. ....

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2. ....

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3. ....

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4. ....

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5. ....

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6. ....

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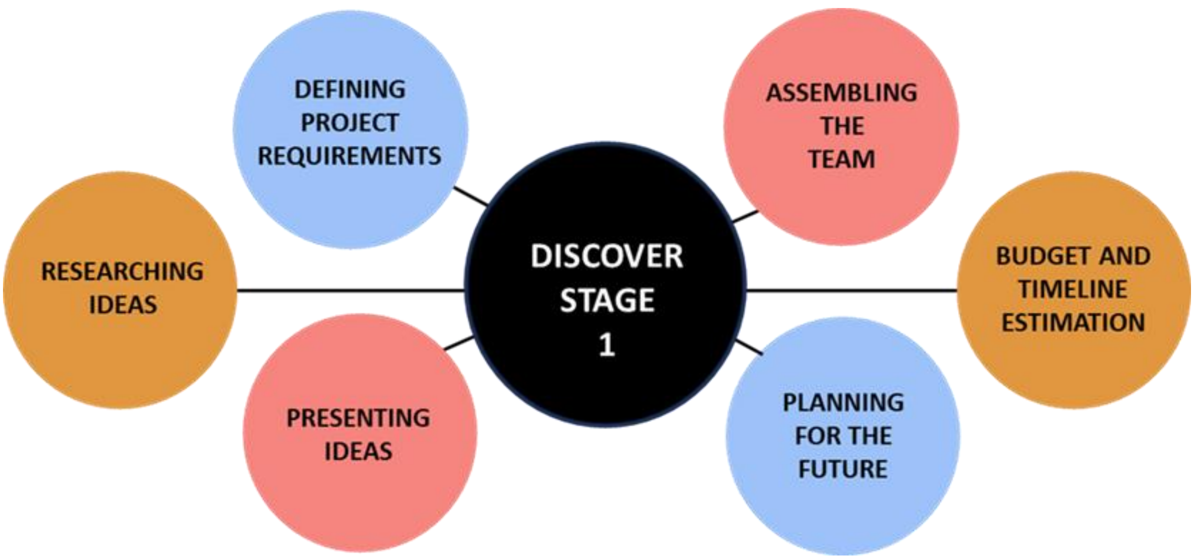


Carry out research

DESIGN STAGE – RISK ASSESMENT

Area Description: ....

Equipment or Process	Hazard Identification	Likelihood	Sewverity	Risk Rating	Engineering Measures	Procedures	Protective Equipment • Sturdy shoes • Safety spectacles • Ear muffs or plugs • Dust masks • Hair restraint • Lab coat or apron	Initiated	Implemented	Reviewed

Notes:

Date: .... Name: .... Signature: ....

UNIT 2 MECHANICAL SYSTEMS DESIGN

Students explore developments in mechanical systems engineering, incorporating the histories, cultures and perspectives of Aboriginal and Torres Strait Islander peoples. They also examine fundamental mechanical engineering principles, concepts and components, as they relate to systems that include the 6 simple machines (lever; inclined plane; pulley; screw; wedge; and wheel and axle). Students analyse the components and materials essential for operational, controlled mechanical systems. By applying the systems engineering process, students create mechanical systems that reflect inclusive design principles.

Students address inclusive design problems, which support communities and improve people's lives, by creating operational systems using the systems engineering process. Inclusive design concepts emphasise creating systems that consider the diverse needs of all people. (Systems Engineering Study Design Page 34)

OUTCOME 1 – EVOLUTION OF MECHANICAL SYSTEMS DESIGN

This area of study explores the historical and technical developments in mechanical systems and examines innovation and inclusive design principles and other influences within mechanical systems. It also examines cultural influences on engineering design, including perspectives from Aboriginal and Torres Strait Islander peoples.

On completion of this unit the student should be able to explain the evolution of mechanical systems and discuss innovation and inclusive responses to mechanical engineering design. (Systems Engineering Study Design Page 34)

HISTORICAL AND TECHNICAL DEVELOPMENTS IN MECHANICAL SYSTEMS

INTRODUCTION

The technological development of Mechanical systems commenced with the Industrial Revolution. The Industrial Revolution was a period of scientific and technological development in the 18th century with the advent of the steam engine that transformed rural societies into industralised urban zones. Everything that was painstakingly made by hand started to be mass produced in large quantities by machines in factories.

Mechanical systems evolved as advances in materials, control technology and design methods have led to continued improvements in machines of all kinds. Over the years machines have become more efficient, faster, more precise, more economical and capable of performing more functions.

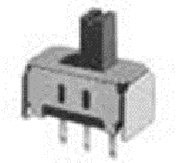
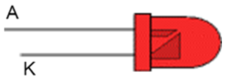
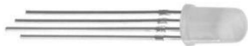
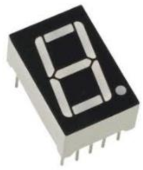
EVOLUTION OF MECHANICAL SYSTEMS DESIGN

You should gain an understanding of:

Aboriginal and Torres Strait Islander peoples' contributions and perspectives and other historical, cultural or technical developments in the field of engineering related to mechanical systems, such as:

- The Archimedes screw.
- The machines of Leonardo Da Vinci.
- The Wright Flyer.
- The Morse code telegraph.

ELECTRONIC COMPONENTS C/W SYMBOLS USED FOR CREATING CONTROLLED MECHANICAL SYSTEMS

Switch (latching) 	Light emitting diode (LED)  	RGB LED 	Light dependent resistor 
Resistor 	Battery 	Variable resistor (Potentiometer) 	Joystick 
Active buzzer 	Passive buzzer 	Piezo buzzer 	DC motor 
Multimeter 	Servo 	Bipolar stepper motor 	Unipolar stepper motor 
Tilt switch  	Radio frequency identification  	Moisture level detector 	Seven segment display 

ARDUINO UNO AND ELECTRONIC COMPONENT'S PART NUMBER E3002 AVAILABLE FROM:

School Electronic Supplies
Contact: Aaron Penna
3 Kiama Close, SCORESBY, VIC. 3179
Phone: (03) 9763 5528 Mobile: 0410 614 171
Email: aaron@schoolelectronicsupplies.com.au

Interfacing to a Microcontroller

Four microcontroller pins are required to control the unipolar stepper motor, Pins 8, 9, 10 and 11.

The ULN2003 Darlington Transistor Array needs to be supplied with a 6 - 9VDC supply and the unipolar stepper motor needs the voltage at which the stepper motor is rated to operate. The 28BYJ-48 unipolar stepper can comfortably use 6 – 9VDC supply.

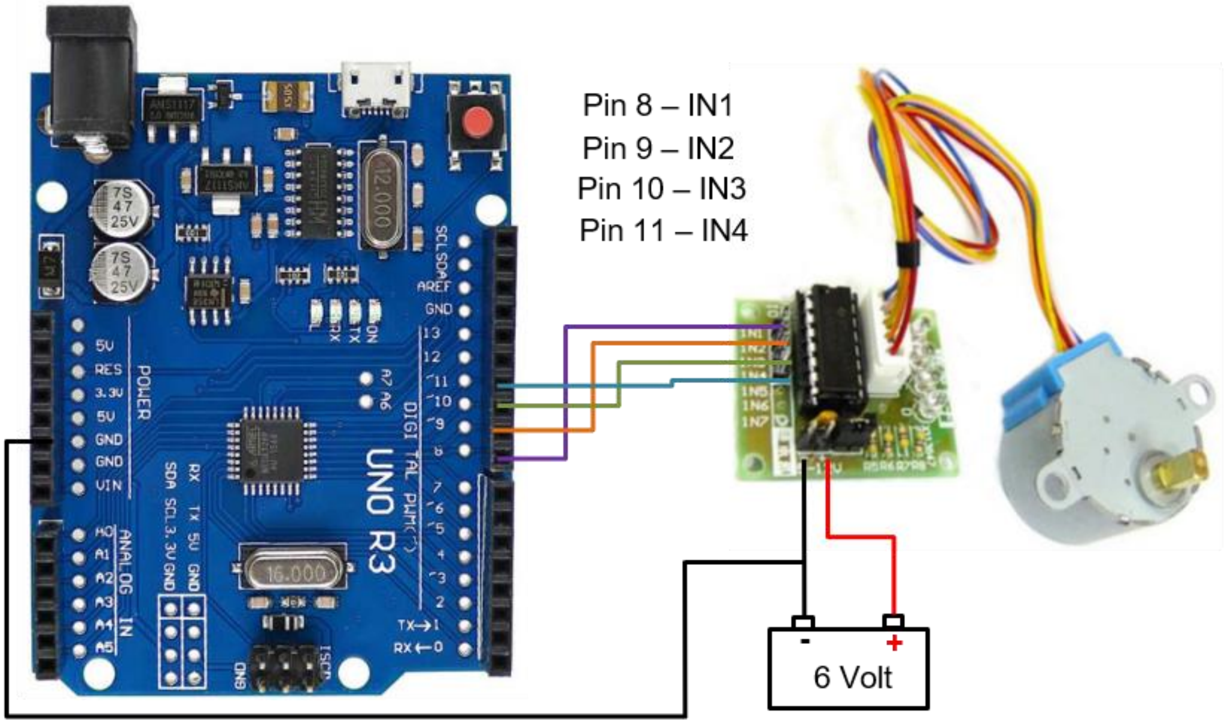
The microcontroller pin can only provide up to 15mA at maximum and can only be used to provide the step and direction signal to the motor driver.

TASK 19: CONTROL A UNIPOLAR STEPPER MOTOR - PROGRAM 1

How: The 28BYJ-48, 5VDC stepper motor is a unipolar stepper motor with five wires because the centre tap of each coil is connected together. It internally steps at 32 steps per revolution. The output shaft of the stepper motor becomes the input shaft into a 64:1 reduction gearbox which now gives 2048 steps per revolution. To control a unipolar stepper motor, carry out the following steps.

Parts required: 1x 28BYJ-48 bipolar stepper motor
1x ULN2003 Darlington transistor array

1. Connect the unipolar stepper motor to the Arduino UNO, as per the following diagram:



Unipolar stepper motor connections

2. Type the sketch on the following page into Arduino IDE

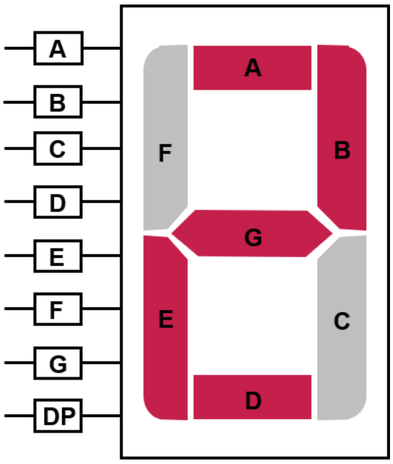
3. Upload the program to your Arduino UNO. When it has done uploading the stepper motor should move 4 steps slowly where you can observe the LED sequence, stop, rotate ½ a revolution clockwise a bit quicker, stop, then rotate ½ a revolution anti-clockwise quickly.

TASK 34: WRITE IN THE CODE FOR THE FOLLOWING NUMBERS

How: Write in the code for the individual segments of a seven segment display that need to be illuminated to produce the following decimal numbers.

Seven segment display for ‘2’. Turn on all segments , , , ,

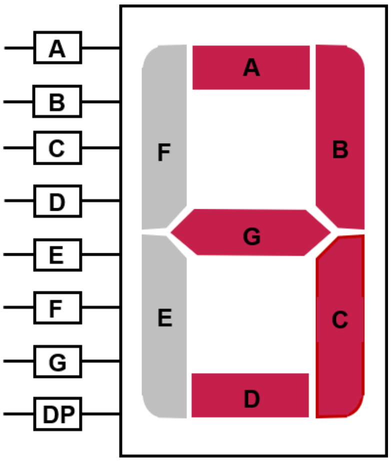
0	1	2	3	4	5	6	7	8	9
1				0		0		1	
1				1		0		1	
1				1		1		1	
1				0		1		1	
1				0		1		1	
1				1		1		1	
0				1		1		1	
N/A									



Digital number 2’

Seven segment display for ‘3’. Turn on all segments , , , ,

0	1	2	3	4	5	6	7	8	9
1		1		0		0		1	
1		1		1		0		1	
1		0		1		1		1	
1		1		0		1		1	
1		1		0		1		1	
1		0		1		1		1	
0		1		1		1		1	
N/A									



Digital number 3’

TASK 35: WRITE IN THE CODE FOR THE FOLLOWING NUMBERS

How: **1.** Write in the code for the individual segments of a seven segment display that need to be illuminated in order to produce the decimal numbers. 1, 5, 7 and 9

Seven segment display for ‘1’. Turn on all segments , ,

Seven segment display for ‘5’. Turn on all segments , , , ,

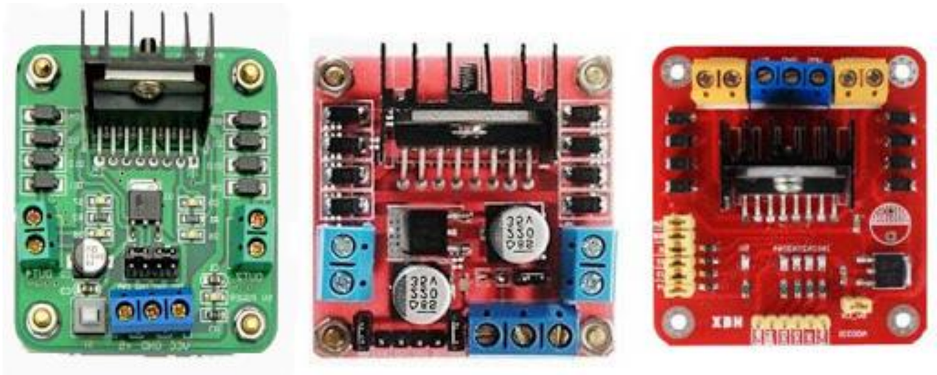
Seven segment display for ‘7’. Turn on all segments , ,

Seven segment display for ‘9’. Turn on all segments , , , ,

2. Complete the table below by writing in the code for the decimal numbers. 5, 7 and 9

L298N DUEL H-BRIDGE MOTOR DRIVER MODULE

The L298N Duel H-Bridge Motor Driver is used to control DC motor speed and direction. It can also be used to control a stepper motor and for other projects such as driving the brightness of lighting projects such as high powered LED arrays. Using the driver module makes it easier for prototyping compared to using the IC



Variety of L293N H-Bridge Motor Driver Modules

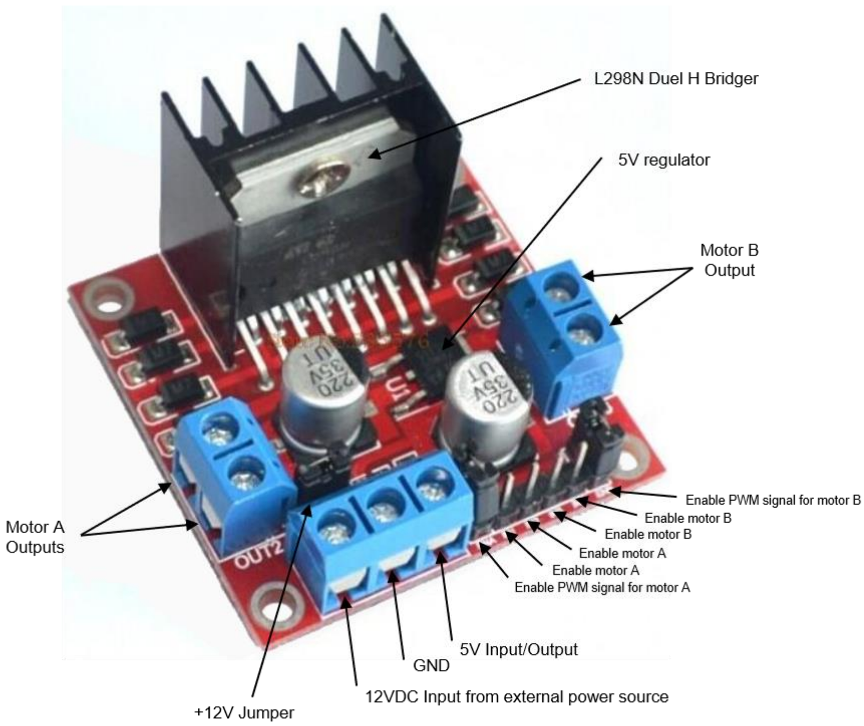
How it works:

The H-Bridge is a circuit that can drive a current in either polarity and the motor speed can be controlled by Pulse Width Modulation (PWM).

The L298N Duel H-Bridge Motor Driver Module has +12V and +5V terminals. The +12V pin is where the power for the motor is attached. This pin can accept voltages from +7VDC to +35VDC.

> ***NOTE: Remove the +12V jumper if you are using powers higher than +12V.***

When the +12V jumper is attached, the on-board voltage regulator is now enabled, and you can source +5V from the +5V terminal. This means the +5V terminal is not for powering the board but for connecting a device, e.g. Arduino UNO, that needs a 5V source.



Components of a L293N H Bridge Motor Driver Module

Speed control

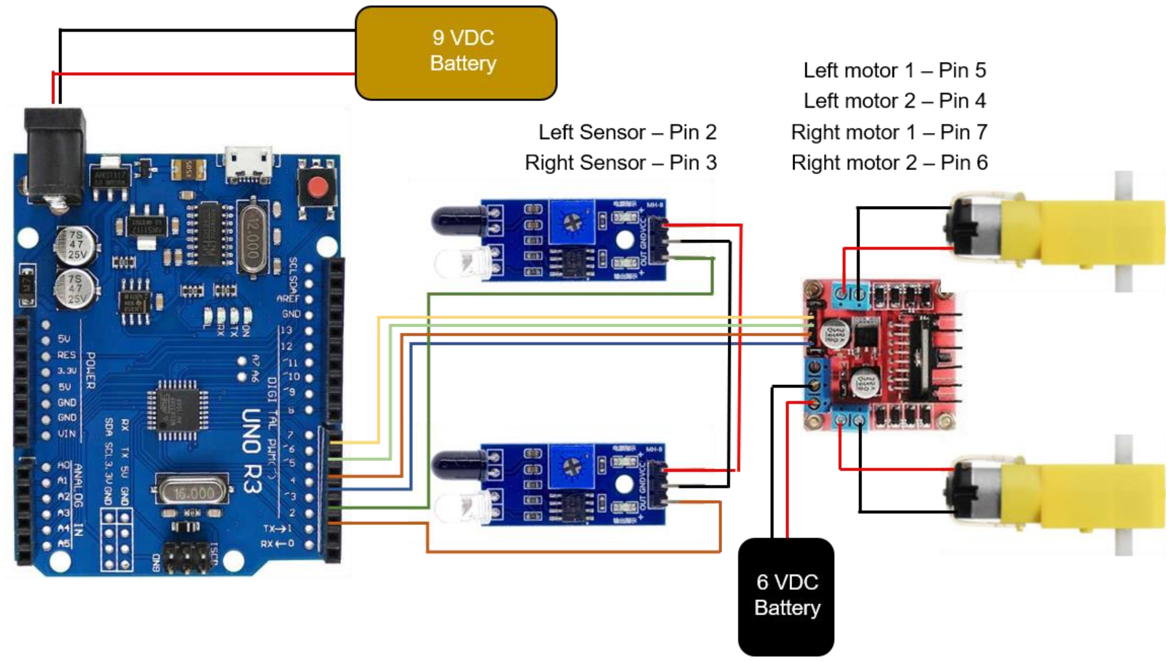
Remove the Enable PMW signal for motors A and B jumpers if you are using DC motors that require speed control. Speed control for Motor A and Motor B is achieved via PWM on these pins. All you need to do is feed PWM signals to the motor enable pins. The speed of the motor will vary according to the width of the pulses. The wider the pulses, the faster the motor rotates. How fast the motor rotates for a given pulse width will vary from motor to motor even if they look the same. Thus, the actual pulse width must be derived through experimentation.

TASK 49: MAKE A LINE FOLLOWER ROBOT

How: Make a line follower robot with adjustable speed that will traverse a course and stop at the end of the course.

Parts required: 2x 6VDC motor 130 RPM, 1x L293N Duel H-Bridge Motor Driver Module, 2**x** IR Obstacle Avoidance sensors, 2x External battery packs

1. Connect the motors, motor driver, sensors and batteries to an Arduino UNO as per the connections diagram below.



Line follower connections

2. Write a program for a line follower robot with adjustable speed that will traverse a course and stop at the end of the course. This can be achieved by carrying out the following steps.

Line_Following_Sketch | Arduino 1.8.13 (Windows Store 1.8.42.0)

File Edit Sketch Tools Help

Line_Following_Sketch

```
#define LS 2 // Defines Pin 2 to the left sensor
#define RS 3 // Defines Pin 3 to the right sensor
#define LM1 5 // Defines connection 1 Pin 5 to left motor
#define LM2 4 // Defines connection 2 Pin 4 to left motor
#define RM1 7 // Defines connection 1 Pin 7 to right motor
#define RM2 6 // Defines connection 2 Pin 6 to right motor
void setup()
{
pinMode(LS, INPUT); // Sets left sensor Pin 2 as an INPUT
pinMode(RS, INPUT); // Sets rught sensor Pin 3 as an INPUT
pinMode(LM1, OUTPUT); // Sets left motor connection 1 Pin 5 as an OUTPUT
pinMode(LM2, OUTPUT); // Sets left motor connection 2 Pin 4 as an OUTPUT
pinMode(RM1, OUTPUT); // Sets right motor connection 1  Pin 7 as an OUTPUT
pinMode(RM2, OUTPUT); // Sets right motor connection 2  Pin 6 as an OUTPUT
}
```

UNIT 2 MECHANICAL SYSTEMS DESIGN

OUTCOME 2 – CREATING MECHANICAL SYSTEMS

On completion of this unit the student should be able to explain and apply basic engineering principles and concepts and engage with the systems engineering process to use components to design and produce a mechanical system that addresses a problem related to inclusive design. (Systems Engineering VCE Study Design pages 35 - 37)

INCLUSIVE DESIGN

Every design decision has the potential to include or exclude someone. Inclusive design is about making informed decisions, by better understanding user diversity, which helps to include as many people as possible. User diversity covers variations in capabilities, needs and aspirations.

Inclusive design is a series of practices that intentionally includes users that experience discrimination due to being part of a minority or oppressed group. Inclusive design creates a positive environment where everyone feels accepted, valued and respected, regardless of their background or identity.

To deliver a useful product to a minority or oppressed group it is necessary to work with them rather than for them. That can be achieved by:

- Interviews.
- Testing prototypes.
- Observation.
- Co-creation (working with the user).

To deliver an inclusive design you must be aware of all aspects of people identities.

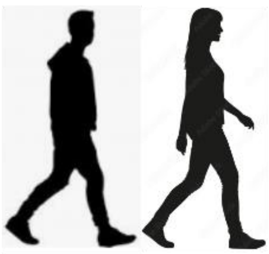
INCLUSIVE MEANS ALL OF US

Inclusive design is a human centered pathway that lead us to better products, systems and services.

Mobility
Mobility devices

Sensory and communication
Vision, hearing speech

Lived experiences
Gender, race, age, culture
LGBTQA+, personal sensitives



Everyone
Physical size (tall, large, short) and physical differences

Wellbeing
Temporary disabilities

Neurodiversity
Autism, different attention span, learning and cognition

