Electronic Basics:-

The Multimeter (Vid-01):-

* $I = \frac{V}{R}$ * $R = \frac{V}{I}$ * $V = IR$

* Multimeter is used to measure voltage, current and resistance.
* Black Probe → common socket
* Red Probe → For Voltage & Resistance → V-Ω-Hz
* Meter Beep → when almost zero resistance, used to check cable break.
* To ~~chee~~ check current use high Amp socket
* Red Probe → (+)ve, Black Probe → (-)ve

Dimming All kinds of LEDs (Vid-02):-

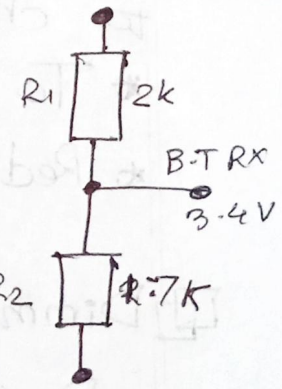
* PWM = Pulse Width Modulation
* Depends upon the voltage
* Fixed Voltage has to be used, potentiometer causes issue for high power LEDs. waste of energy through potentiometer.
* oscilloscope, switching between 5V and 0V
* lowering duty cycle → ~~to~~ dimming the lights.
* analogWrite (ledpin, potentiometervalue)

Programming an ATtiny + Homemade Arduino Shield (Vid-03):-

* ATtiny 85 - microcontroller, cost effective, efficient
* Building an Arduino Shield
* Downloading Arduino Software

Arduino + Bluetooth + Android = Awesome (Vid-04)

* Bluetooth Transceiver
* Arduino - 5V, B.T Transceiver - 3.3V
* TX - Transmit Pin, RX - Receive Pin
* S2 Terminal App
* Learn Arduino Code



How to Multiplex (Vid-05)

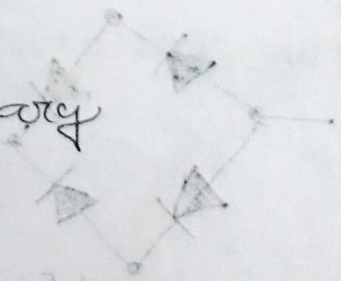
* Controlling Multiple LEDs -
* Light up each row individually - multiplex
* Arduino UNO
* Fewer pins required, efficient control on multiple displays, ideal for clocks, timers and counters.

Standalone Arduino Circuit :- (Vid-06)

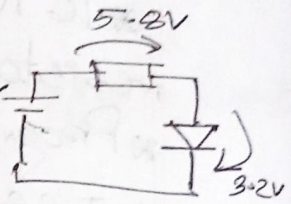
* 16 MHz clock crystal, 22pF capacitor, 10kΩ resistor,
* Programming ATmega
* ICSP = In Circuit Serial Programming.
* Making Arduino on Breadboard
* No reset switch, no circuit protection, no over-voltage protection.

7Segment Display :- (Vid-07)

* 7 Segment Display :- One digit in one case, or two digits in one case.
* Check datasheet - 2.1 Volts
* Using PCB for displaying number
* 4 pin binary counter
* Adding push button / sensor to count number
* Using multiplexing, or a number IC
* Controls 4 digits, multiplexing 2 digits at a time
* Using cool-SAA1064 library

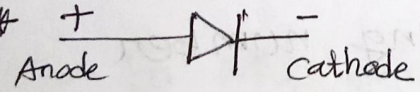


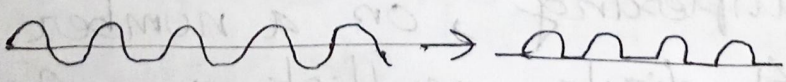
Everything about LEDs and Current Limiting Resistors (Vid - 8)



* Forward Voltage and Current
* Careful about power, burn resistor
* Small voltage change in power source can destroy all LEDs. Solution – using small resistor.
* Use LED in constant current, not constant voltage
* Use constant current driver

Diodes and Bridge Rectifiers :- (Vid-09)

* Diode prevents current flow to other way.
* 

* Voltage drop exists, waste of ~~to~~ power
* AC → DC
* Calculated in RMS Value
* 
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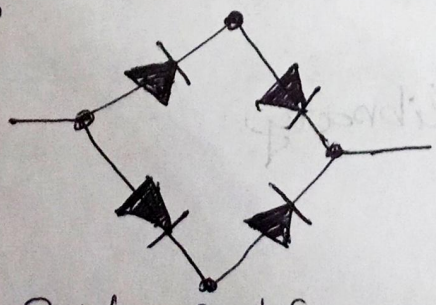
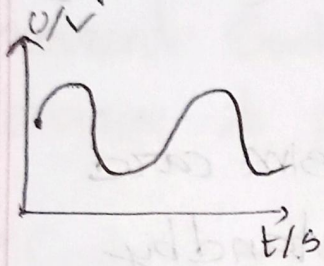
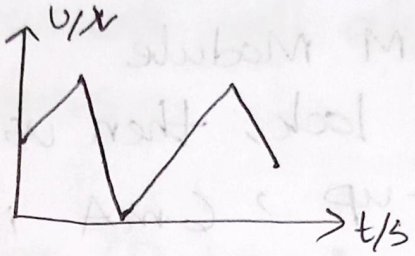
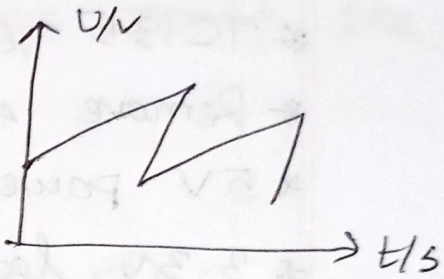


Bridge Rectifier

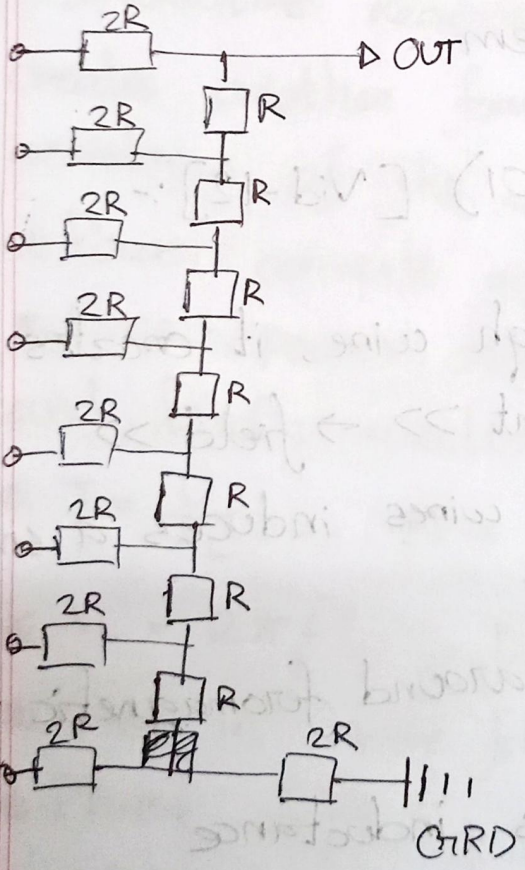
Digital to Analog Converter (DAC) (Vid-10)



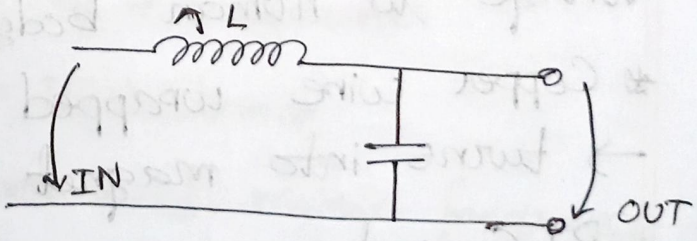




* 8 bit R-R DAC



* Ramp function, triangle function
* Connect speaker via voltage follow-up
* DAC-0800
* Analog-write function
* LC Low pass filter:-



* 12 bit DAC - audio filter, DAC generator

Sending SMS Using Arduino (Vid-11)

* TC 35 GSM Module
* Remove sim lock, then use sim card
* 5V power-up ; 6mA in standby
* 3.3V logic level , 9600 baud rate
* Use as alarm system

Coils / Inductors (Part-01) [Vid-12] :-

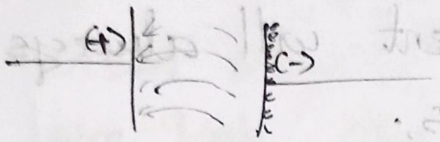
* Basics of inductors
* When current flows through wire, it creates magnetic field around it. current >> → field >>
* The magnetic field of wires induces a small voltage to human body
* Copper wire wrapped around feromagnetic metal → turns into magnet
* RLC meter → measures inductance
* Lenz Law :- $W = \frac{1}{2} J^2$
* flyback diode to protect switch
* The voltage at circuits lets current flow. This current starts creating a magnetic field, which

induces voltage to the coil itself, produces induced current. Such current will always oppose the change it produces.

Coils / Inductors (Part-02) [Vid-13]:-

* Inductive Reactance:- The inductance of an inductor creates another form of resistance aside the resistance of the wire, this is called reactance. (X_L)
* Power converts into magnetic field
* Cons:- power oscillates between voltage source and load; reactive power
* $I = \frac{U}{X_L}$, $\uparrow F \rightarrow \uparrow X_L \rightarrow \downarrow$ Current
* $X_L = 2\pi f L$, L = Inductance
* Use in noise filter and music frequency filter
* Phase shift → inductance in circuit
* Alternate to RLC meter → transistor tester

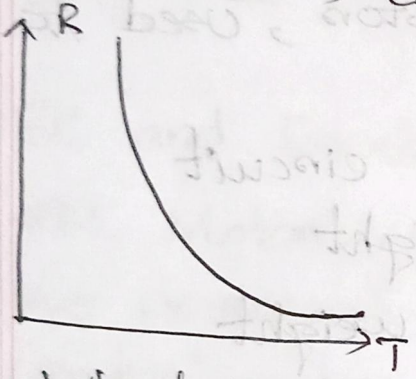
Capacitors :- (Vid - 14)



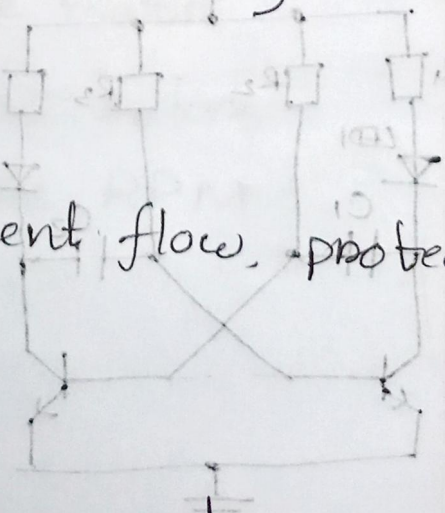
* Dielectric material like water increases capacitance.
* Electrolytic Capacitor → metal sheet with dielectric material within
* Reversing polarity destroys
* Basic capacitor → metal sheet with dielectric substance in the middle
* Increasing capacitance - bringing the plates closer, using dielectric.
* Switching operation → create different signals using resistor, creates capacitive reactance (X_C) in AC. $X_C \sim \frac{1}{fC}$
* Capacitance ↓ current ↓
* frequency ↓ current ↓
* $X_C = \frac{1}{2\pi f C}$
* creates phase shift.

Temperature Measurement (Part-01) [Vid-15]

* NTC = Negative Temperature Coefficient, thermister
* Resistors → decrease value as temperature rises



* PT-100, 0°C → 100 Ω
  Resistance increases with higher Temperature → max → @ 850°C
* Voltage offset
* Wheatstone Bridge → temperature calculating via the change of resistance
* 10-turn potentiometer / pre-made transmitter
* Voltage drop → analog input
* LCD connect → shows temperature
* LM 35 → IC (0–1.5 V, 0°–150°C)
* Thermal Inertia



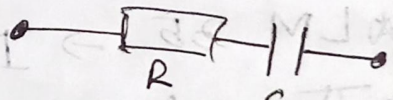
Resistors [Vid-16] :-

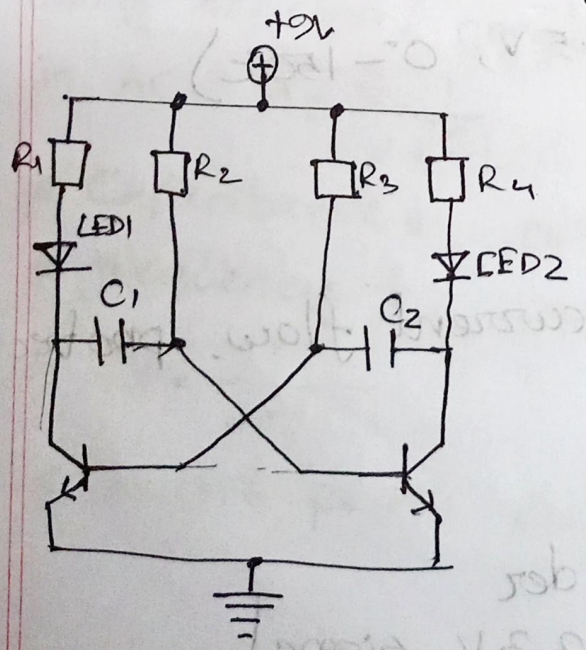
* Resists the excess current flow, protecting equipment
* Power Resistors
* Series → voltage divider
* 5V data signal to 3.3V signal

* Pull-down resistor – pulls to ground level
* Pull-up resistor
* Shunts → small value resistor, used to build load
* Used as fuses to protect circuit
* Photoresistor → detect light
* Strain Gauge → measure weight
* AC 50Hz Sine voltage → don't produce phase shift

Oscillator [Vid-17] :-

* Oscillator – creates periodic alternate voltage signals
* Relaxation Circuit (R-C) :-





* Create rectangle wave
* LC Resonator, tank circuits
* Parasitic Resistance
* $|X_C| = |X_L|$
* Resonance frequency
* Using amplifier – stable MHz sine wave

* crystal oscillator → more stable frequency works like L.C resonator, mechanical vibration of a PZO crystal.

DC and Brushless DC Motor + ESC (Vid - 13)

* DC Motor:- uses direct current for rotory movement two permenant magnets of opposite polarity (stator). rotor consists of 5 coils connected to the commutator, two copper brushes
* Brushless motor - electrical circuit to create magnetic field.

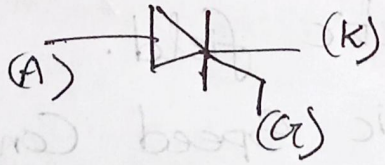
* ESC → Electric Speed Controller
* Total current consumption depends on what load is connected to the motor
* High torque → brushless motors
* More KV rating → more RPM

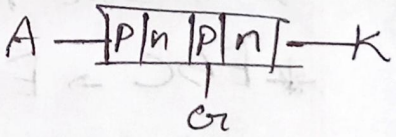
I2C and How to Use it [Vid-19]

* I^2C → Two wire interface, popular comm. protocal that allows one or more master devices to talk to upto 112 slave devices
* Print out data sheet
* wire library
* address - fixed 7 bit value
* PLL value

Thyristor, Triac || Phase Angle Control [Vid-20]

* Thyristor - controllable diode, can't be turned on or off





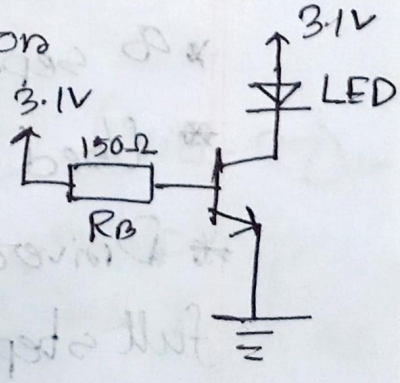
* TYN 604
* Latching Current
* MOSFET → used as switch
* turnoff time
* Triac
* fe-radical schematic
* Cons:- constantly decreasing power factor

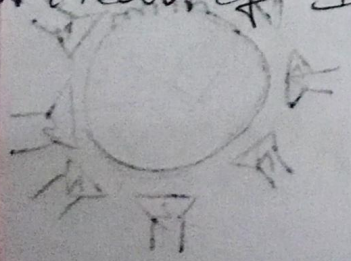
OpAmp (Operational Amplifier) [Vid - 21] :-

* 8 pins / 14 pins
* The output of an OpAmp will always attempt everything to keep Vdtage diff. between inputs at 0 V.
* Amplify signal from a sensor
* DC offsets
* Rail - to - Rail Op Amp → $V_{output} = V_{supply}$
* Input Draws no current
* When no feedback is attached between the outputs and inputs; the outputs will peak.
* Comparator IC

Transistor as a Switch (BJT) [Vid - 22]

* BJT = Bipolar Junction Transistor
* Use as switch, or amplifier
* Base, Emitter, Collector
* Heating Issue as switch



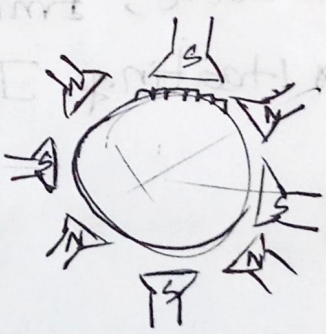


Transistor (MOSFET) as a switch:- [Vid-2

* MOSFET → 0.6 W energy loss, 97% efficie
* Two types - N channel and P channel
* GS > Voltage > T.V
* Electrostatic voltage of body can turn on the loads, put resistor to prevent so
* Bootstrapping - P channel MOSFET, pull-up
* 1.15 Ω resistor between gate and resisto
* Ardui
* Gate, Source, Drain
* Energy loss at the gate

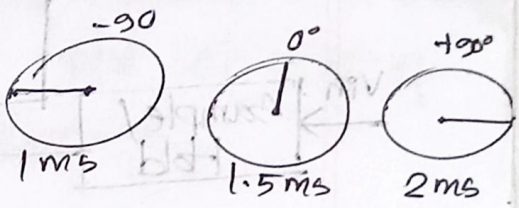
Stepper Motors and How to Use them [Vid-24]

* Stepper Motor - Hybrid Synchronous, 4 magnets 50 teeth per sprockets
* 2 separate coil motor
* Used in 3D printers
* Drivers:- wave driving
full step / half step driving

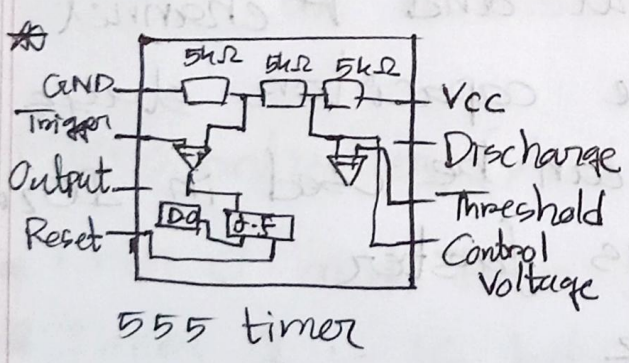


Servos and How to Use them (Vid-25):-

* Servo :- Motor driven positioning system
* Ground, VCC, Control Signal
* Potentiometer inside servo
* H-Bridge
* N channel, P channel mosfets
* servo library
* Gear DC motor for 360° rotation



555 timer IC (Vid-26):-



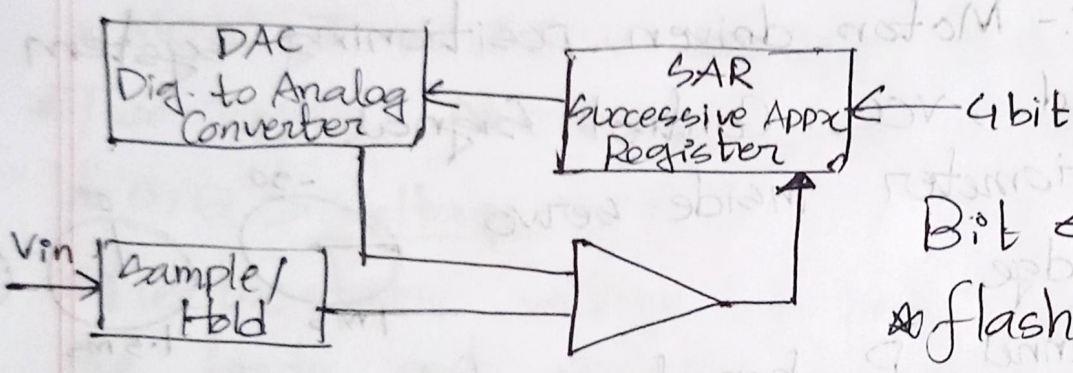
555 timer

* monostable multivibrator configuration
* Two additional diodes

ADC (Analog to Digital Converter) (Vid-27):-

* Nyquist - Shannon Theorem :- The sampling Rate should be at least twice as high as the frequency of the signal.

* sampling rate



Bit ↔ Resolution

* flash ADC

IGBT and When to Use them [Vid-28]:-

* IGBT = Insulated Gate Bipolar Transistor
* 2 types - N channel and P channel
* Gate behaves like capacitor, stays on
* MOSFET Driver can be used in IGBT
* MOSFET switches faster
* IGBT < 200kHz
* IGBT has greater power loss (32 times)

Solar Panel and Charge Controller (Vid-29)

* Individual Solar Cells, when exposed to light, creates electrical energy
* Charge Controllers:- manage the charging process and protect the batteries.
* 2 types:- PWM:- simpler cost efficient option that reduces the voltage of solar panel to match the battery voltage

MPPT:- A more advanced and efficient controller targets at harvesting maximum power

Microcontroller (Arduino) Timers (Vid-30)

* Timer 0 and Timer 2:- 8 bit timer
* Timer 1:- 16 bit timer
* Normal Mode:- counts upto maximum value, then overloads
* CTC (Clear Timer on Compare Match) Mode:- The timer resets matching specified mode
* PWM:- Used to control motors and LEDs

* Configuring Timers:-

TCCRnA and TCCRnB

ORCnA / ORCnB

TIMSKn