

**Programme Name/s** : Electrical Engineering/ Electrical Power System  
**Programme Code** : EE/ EP  
**Semester** : Second  
**Course Title** : ELEMENTS OF ELECTRONICS  
**Course Code** : 312309

### I. RATIONALE

Diploma in Electrical Engineering students need to maintain and operate electronics systems. This course deals with basic operating principles and handling of electronics devices to troubleshoot electronics circuits used in Electrical system.

### II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use electronic components and circuits in electrical equipment and systems

### III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify various electronic components
- CO2 - Use semiconductor diodes in different applications.
- CO3 - Use semiconductor transistors in different applications.
- CO4 - Use different types of Oscillators as per requirement
- CO5 - Test operation of regulated power supply.

### IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title            | Abbr | Course Category/s | Learning Scheme          |     |     |     |                |        | Credits | Assessment Scheme |                  |     |     |     |             |     |             |    |    |     |
|-------------|-------------------------|------|-------------------|--------------------------|-----|-----|-----|----------------|--------|---------|-------------------|------------------|-----|-----|-----|-------------|-----|-------------|----|----|-----|
|             |                         |      |                   | Actual Contact Hrs./Week |     | SLH | NLH | Paper Duration | Theory |         |                   | Based on LL & TL |     |     |     | Based on SL |     | Total Marks |    |    |     |
|             |                         |      |                   | CL                       | TL  |     |     |                | LL     |         | Practical         |                  |     | SLA |     |             |     |             |    |    |     |
|             |                         |      |                   | Max                      | Max | Max | Max |                | Min    |         | Max               | Min              | Max | Min | Max | Min         |     |             |    |    |     |
| 312309      | ELEMENTS OF ELECTRONICS | EOE  | DSC               | 4                        | -   | 4   | 2   | 10             | 5      | 3       | 30                | 70               | 100 | 40  | 25  | 10          | 25@ | 10          | 25 | 10 | 175 |

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

### V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's) aligned to | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|-------|---|---|--------------------------------|
|-------|---|---|--------------------------------|

|   | CO's.  |  |   |
|---|--|--|---|
| 1 | <p>TLO 1.1 Differentiate between given active and passive electronic components.</p> <p>TLO 1.2 Calculate value of given resistor and capacitor using colour code and printed information.</p> <p>TLO 1.3 Interpret with sketches given signal.</p> <p>TLO 1.4 Compare characteristics of given voltage and current source</p>                                     | <p><b>Unit - I Electronic components and Signals</b></p> <p>1.1 Active and passive components</p> <p>1.2 Resistor,Capacitor,inductor,symbols,applications,colour codes, specifications</p> <p>1.3 Concept of Unipolar and Bipolar Devices.</p> <p>1.4 Classification of signals-sinusoidal, triangular and square</p> <p>1.5 Signal waveform ,Time and Frequency domain, Representation, Amplitude,Frequency,phase,wavelength</p> <p>1.6 Voltage and current source Ideal and non ideal Sources</p> <p>Dependent voltage and current sources .</p>   | <p>Chalk-Board Assignment</p> <p>Demonstrations</p> <p>Hands-on</p> |
| 2 | <p>TLO 2.1 TLO 2.1 Check the operation of the given diode</p> <p>TLO 2.2 TLO 2.2 Plot V-I characteristic of the given diode</p> <p>TLO 2.3 TLO 2.3 Describe working Principle of given type of Rectifier without and with Filter.</p> <p>TLO 2.4 TLO 2.4 Explain given type of wave shaping circuits</p>   | <p><b>Unit - II Semiconductor Diodes</b></p> <p>2.1 Construction, symbol, working principle, specification, applications ,types of biasing and V-I characteristic of Zener diode ,LED , Photo diode. Working principle and applications of OLED</p> <p>2.2 Rectifiers- Full wave center tapped and Bridge Rectifier, circuit diagram, wave forms ,working principle . Rectifier IC KBU 808 Pin diagram and applications</p> <p>2.3 Parameters of rectifier: Average DC value of current and voltage, ripple factor, PIV of diode, TUF and efficiency of rectifier.</p> <p>2.4 Need of filters ,Types- C,LC,CLC,L ,circuit diagram wave forms and working principle.</p> <p>2.5 Wave shaping circuits Linear and non linear wave shaping -RC integrator, RC Differentiator, Diode based Clipper circuits , Diode based Clamper. Circuits</p>  | <p>Chalk-Board Assignment</p> <p>Presentations</p> <p>Hands-on</p>  |
| 3 | <p>TLO 3.1 Describe the working of the given type of transistors</p> <p>TLO 3.2 Compare the performance of three type of transistor configurations.</p> <p>TLO 3.3 Solve simple numerical on Current gains.</p> <p>TLO 3.4 Use transistor for various applications ( Amplifier and Switch ) .</p> <p>TLO 3.5 Explain working of given type of JFET and MOSFET.</p> | <p><b>Unit - III Semiconductor Transistors</b></p> <p>3.1 Current operating Devices, Bipolar Junction Transistor- Types NPN , PNP, symbol, construction and working principle .</p> <p>3.2 Need of biasing ,Types- Fixed bias and Voltage divider bias</p> <p>3.3 Regions of operation and their significance - Cut off region , Active region and Saturation region</p> <p>3.4 Transistor configurations: CB, CE, CC, working , comparison and applications</p> <p>3.5 Transistor parameters- Alpha, Beta, Gamá, Input, and output resistance, Relationship between alpha and beta, numerical on same.</p> <p>3.6 Applications- Transistor as an amplifier- Small signal and power amplifier , Class A, Class B, Class C, Class AB Amplifier , Transistor as a switch ,</p> <p>3.7 Voltage operating devices, Construction Of JFET(N-Channel and P channel),symbol ,working principle, different parameters of JFET and applications.</p> <p>3.8 MOSFET: Construction ,symbol ,working principle of Enhancement and Depletion MOSFET, and their applications.</p> | <p>Chalk-Board Assignment</p> <p>Demonstration</p> <p>Hands-on</p>  |
| 4 | <p>TLO 4.1 Explain working principle of Oscillator with its need.</p>  | <p><b>Unit - IV Oscillators</b></p> <p>4.1 Oscillator: Need, Definition</p> <p>4.2 Types of feedback: Positive feedback, Negative feedback. Barkhausen's criterion</p>   | <p>Chalk-Board Assignment</p> <p>Demonstration</p> <p>Hands-on</p>  |

|   |  |   |   |
|---|--|---|---|
|   | TLO 4.2 Compare the performance of the given feedback.<br>TLO 4.3 Explain Barkhausen's criterion.<br>TLO 4.4 Describe working of the given type of oscillator with circuit diagram.                                | 4.3 Oscillator: Circuit Diagram , working and comparison of RC ,LC, and Crystal oscillator.<br>4.4 Types of RC oscillator- Wien bridge and RC Phase shift Oscillator Frequency calculation<br>4.5 Types of LC oscillator-Colpitts oscillators ,Hartley oscillators.Frequency calculation  |   |
| 5 | TLO 5.1 Explain parameters of voltage regulators.<br>TLO 5.2 Calculate output voltage of the given regulator.<br>TLO 5.3 Check the working of the given type of regulator ICs.<br>TLO 5.4 Explain working of SMPS. | <b>Unit - V Regulators and power supply.</b><br>5.1 Voltage regulation Load and line regulation :Definition, formulae<br>5.2 Block diagram, Construction, and operation of DC Regulated power supply<br>5.3 Basic Zener diode as a voltage regulator.<br>5.4 Regulator IC's: IC's 78XX,79XX ,IC 723 as fixed, variable and Dual Regulated DC power supply<br>5.5 Switch mode power supply: Need, block diagram and working. | Chalk-Board Assignment<br>Demonstration<br>Hands-on |

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO)  | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles  | Number of hrs. | Relevant COs |
|---|-------|---|----------------|--------------|
| LLO 1.1 Identify active and passive components in given circuit<br>LLO 1.2 Measure the value of given resistors on Digital Multimeter(DMM)<br>LLO 1.3 Test Diode and LED on Digital Multimeter. | 1     | Identification of Active and Passive components and DMM handling.   | 4              | CO1          |
| LLO 2.1 Measure amplitude, time period and frequency of given signal on CRO   | 2     | Measurement of amplitude, time period and frequency of given signal on CRO                                      | 2              | CO1          |
| LLO 3.1 Check PN junction Diode in forward bias. and Plot the V-I characteristics of PN junction diode and determine cut in voltage.  | 3     | Check the performance of PN Junction diode.   | 2              | CO2          |
| LLO 4.1 Check the performance of Zener diode in forward and reverse biasing   | 4     | * Check performance of Zener diode.   | 2              | CO2          |
| LLO 5.1 Build the circuit for Photo Diode and Observe the change in current with change in light intensity of the source  | 5     | Test the performance of photo diode by varying the light intensity as well as the distance of the light source. | 2              | CO2          |
| LLO 6.1 Construct and test half wave rectifier on breadboard .  | 6     | * Construct and Test the half wave rectifier.   | 2              | CO2          |
| LLO 7.1 Prepare the circuit for Half Wave Rectifier with LC filter/ pi filter using PN junction Diode .<br>LLO 7.2 Observe and draw input & output waveforms for sinusoidal wave .              | 7     | *Prepare and Test the half wave rectifier with LC filter/ $\pi$ filter  | 2              | CO2          |
| LLO 8.1 Build the circuit for Full Wave Centre Tapped Rectifier using PN junction Diode.<br>LLO 8.2 Observe and draw input & output waveform for sinusoidal wave                                | 8     | *Build and Test the full wave rectifier using two diodes  | 2              | CO2          |
| LLO 9.1 Construct the circuit for Full Wave Bridge Rectifier using PN junction Diodes<br>LLO 9.2 Observe and draw input and output waveform for sinusoidal wave                                 | 9     | * Construct and Test the full wave Bridge rectifier on bread board using four diodes                            | 2              | CO2          |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>   | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                       | <b>Number of hrs.</b> | <b>Relevant COs</b> |
|---|--------------|---|-----------------------|---------------------|
| LLO 10.1 Build the circuit for Full Wave Rectifier using PN junction Diode with LC/Pi filter<br>LLO 10.2 Calculate ripple factor for given setup.   | 10           | *Use LC/ $\pi$ filter with full wave rectifier to measure ripple factor.                | 2                     | CO2                 |
| LLO 11.1 Prepare the circuit for full wave rectifier using IC KBU 808 with filter<br>LLO 11.2 Observe and draw input & output waveform for sinusoidal wave.                                     | 11           | * Prepare and Test the full wave rectifier on bread board using IC KBU 808 with filter. | 2                     | CO2                 |
| LLO 12.1 Build/Test positive Clipper circuit.<br>LLO 12.2 Build/Test negative Clipper circuit.  | 12           | *Build clipper circuit and observe the waveforms.                                       | 2                     | CO2                 |
| LLO 13.1 Construct and Test Positive Clamper Circuit<br>LLO 13.2 Construct and Test negative Clamper Circuit  | 13           | * Construct clamper circuit and observe waveforms.                                      | 2                     | CO2                 |
| LLO 14.1 Identify the terminals of the PNP and NPN transistor for TO-5, TO-220, TO-66<br>LLO 14.2 Selection of transistor for different parameters as max. voltage, current and switching speed | 14           | Identify and select transistors for given application using datasheets                  | 2                     | CO3                 |
| LLO 15.1 Build the circuit for BJT in common base configuration<br>LLO 15.2 Plot input and output characteristics of common base configuration  | 15           | Build and Test the performance of BJT in CB mode  | 2                     | CO3                 |
| LLO 16.1 Construct the circuit for BJT in common emitter configuration.<br>LLO 16.2 Plot input and output characteristics of common emitter configuration.                                      | 16           | * Construct and test the circuit for BJT in common emitter configuration.               | 2                     | CO3                 |
| LLO 17.1 Test the performance parameters of BJT as Switch<br>LLO 17.2 Identify Cutoff and saturation regions.   | 17           | *Test the performance parameters of BJT as Switch                                       | 2                     | CO3                 |
| LLO 18.1 Build the circuit for FET in common source configuration.<br>LLO 18.2 Plot characteristics for drain to source voltage VDS verses drain current ID for different Values of VGS         | 18           | * Check the performance of FET drain Characteristics.                                   | 2                     | CO3                 |
| LLO 19.1 Build the circuit for FET in common source configuration<br>LLO 19.2 Plot characteristics for Gate to source voltage VGS verses drain current ID and calculate transconductance.       | 19           | Test the performance of FET transfer characteristics and calculate transconductance.    | 2                     | CO3                 |
| LLO 20.1 Build the circuit and measure the frequency of given LC Oscillator circuit<br>LLO 20.2 Build the circuit and measure the frequency of given RC Oscillator circuit                      | 20           | Measure the frequency of given Oscillator circuit                                       | 2                     | CO4                 |
| LLO 21.1 Test the voltages & waveforms at various Test points of regulated dc power supply.<br>LLO 21.2 Identify the various faults in the Regulated DC power supply                            | 21           | *Find out faults at different stages of regulated DC power supply                       | 2                     | CO5                 |
| LLO 22.1 Rectify the various faults in the Regulated DC power supply.   | 22           | *Trouble shoot given DC regulated power supply  | 2                     | CO5                 |

| Practical / Tutorial / Laboratory Learning Outcome (LLO)  | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles  | Number of hrs. | Relevant COs |
|---|-------|---|----------------|--------------|
| LLO 23.1 Build Zener voltage regulator for given voltage.<br>LLO 23.2 Calculate load and line regulation.   | 23    | *Build and Test the performance of Zener voltage regulator for given voltage.   | 2              | CO5          |
| LLO 24.1 Construct the circuit for Positive voltage regulator using 78XX IC.<br>LLO 24.2 Calculate load and line regulation.  | 24    | * Construct and Test the performance of Positive voltage regulator using 78XX , three terminal IC for given voltage.  | 2              | CO5          |
| LLO 25.1 Prepare the circuit for Dual voltage regulator using 78XX and 79XX IC<br>LLO 25.2 Calculate load and Line regulation.  | 25    | * Prepare and Test the performance of Dual voltage regulator using 78XX and 79XX ,three terminal IC for given voltage | 2              | CO5          |
| LLO 26.1 Build LOW/High voltage regulator circuit using IC LM723. Calculate load and line regulation  | 26    | *Test the performance of IC 723 as Regulator.   | 2              | CO5          |
| <b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>* Marked Practicals (LLOs) Are mandatory.</li> <li>Minimum 80% of above list of lab experiment are to be performed.</li> <li>Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul> |       |   |                |              |

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

### Micro project

- Transistor as switch- Build /Test transistor switch circuit on General purpose PCB for various input signals
- Diode: Build a circuit on general purpose PCB to clip a positive half cycle at 1.5 v of a waveform with input signal 5V<sub>pp</sub>, and prepare the report
- Diode: Build a circuit on general purpose PCB to clamp a waveform at 3.0 V using diode and passive components.
- Photodiode: Build a circuit on breadboard to turn the relay on and off by using photo diode and prepare a report.
- Rectifier: Build a half wave rectifier for 6V, 500mA output current on general purpose PCB.
- Rectifier: Build a full wave bridge rectifier with capacitor filter for 6V, 500mA output current on general purpose PCB
- Using Data sheets compare various electronic parameters of different types of JFET and MOSFET.
- Transistor as switch- Build /Test transistor switch circuit on General purpose PCB for various input signals
- Transistor- Build a circuit to switch on and off the LED using BJT as a switching component
- Voltage Regulator: Build a circuit of DC regulated power supply on general purpose PCB for 9V and 500mA output
- Oscillator: Build circuit to generate audio frequency.
- Prepare display boards/models/charts to visualize the appearance of electronic active and passive components.

### Assignment

- Study Different types of Rectifier ICs available.
- Study working of OLED Display.

#### Note :

This is a suggestive list of micro project and assignments , Similar activities can be set for relevant skill development For this course in L A scheme 2 hrs per week are allocated for self learning, Course teacher shall allocate micro project or / and assignments by considering 30 hrs SL work . Micro project may be assign for a team of 4 to 5 students .SL work shall be assessment is a formative ( continuous )assessment . Depending on allocated task Course teacher shall set rubrics , This continuous assessment record will be helpful for SLA

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications  | Relevant LLO Number   |
|-------|---|-----------------------|
| 1     | Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current. | 3,4,11,12,16,17,18,19 |

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| Sr.No | Equipment Name with Broad Specifications  | Relevant LLO Number               |
|-------|---|-----------------------------------|
| 2     | Cathode Ray Oscilloscope Dual Trace 20Mhz. 1 5Mega ohm Input impedance  | 5,6,7,8,9,10                      |
| 3     | Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude.   | 2,5,6,7,8,9,10                    |
| 4     | Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: Vae Vee (1000V max), Ade- Aae (10 amp max), Resistance (0-100 MS2). Capacitance and Temperature measurement | All                               |
| 5     | Lux meter 3000 Lumen. Battery operated hand held type   | 4                                 |
| 6     | Trainer Kits/Breadboard for Rectifiers, Regulators, Transistors, JFET   | 5,6,7,8,9,10,11,13,14,16,17,18,19 |

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

| Sr.No              | Unit | Unit Title                        | Aligned COs | Learning Hours | R-Level   | U-Level   | A-Level   | Total Marks |
|--------------------|------|-----------------------------------|-------------|----------------|-----------|-----------|-----------|-------------|
| 1                  | I    | Electronic components and Signals | CO1         | 10             | 4         | 4         | 4         | 12          |
| 2                  | II   | Semiconductor Diodes              | CO2         | 14             | 4         | 6         | 6         | 16          |
| 3                  | III  | Semiconductor Transistors         | CO3         | 14             | 4         | 6         | 6         | 16          |
| 4                  | IV   | Oscillators                       | CO4         | 12             | 4         | 4         | 6         | 14          |
| 5                  | V    | Regulators and power supply.      | CO5         | 10             | 4         | 4         | 4         | 12          |
| <b>Grand Total</b> |      |                                   |             | <b>60</b>      | <b>20</b> | <b>24</b> | <b>26</b> | <b>70</b>   |

**X. ASSESSMENT METHODOLOGIES/TOOLS**
**Formative assessment (Assessment for Learning)**

- Each practical will be assessed considering 60% weightage to process and 40% product based on the nature of practicals.
- Two formative assessment tests for 30 marks and average of two unit tests.

**Summative Assessment (Assessment of Learning)**

- End semester assessment of 25 marks for laboratory learning
- End semester assessment of 70 marks

**XI. SUGGESTED COS - POS MATRIX FORM**

| Course Outcomes (COs) | Programme Outcomes (POs)                     |                       |                                       |                        |  |                         |                         | Programme Specific Outcomes* (PSOs) |       |       |
|-----------------------|--|-----------------------|---------------------------------------|------------------------|--|-------------------------|-------------------------|-------------------------------------|-------|-------|
|                       | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1                               | PSO-2 | PSO-3 |
| CO1                   | 2  | -                     | 1                                     | 1                      | 1  | -                       | 2                       |                                     |       |       |
| CO2                   | 2  | -                     | 1                                     | 1                      | 2  | -                       | 2                       |                                     |       |       |
| CO3                   | 2  | 1                     | 1                                     | 1                      | 2  | 1                       | 2                       |                                     |       |       |
| CO4                   | 2  | 1                     | 1                                     | 1                      | 2  | 1                       | 2                       |                                     |       |       |
| CO5                   | 2  | 1                     | 1                                     | 1                      | 2  | 1                       | 2                       |                                     |       |       |

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
 \*PSOs are to be formulated at institute level

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

| Sr.No | Author  | Title   | Publisher with ISBN Number   |
|-------|---|---|--|
| 1     | V .K. Mehta ,Rohit Mehta                        | Principles of Electronics                       | S.Chand and Company Ram Nagar, New Delhi-110 055,11th edition 2014, ISBN 9788121924504 |
| 2     | B.L.Theraja                                     | Basic Electronics                               | S. Chand Publishing, 2007,ISBN:9788121925556   |
| 3     | R.S.Sedha                                       | A textbook of Applied Electronics               | S Chand, New Delhi 2008, ISBN:978-8121927833   |
| 4     | Mottershead,Allen                               | Electronic Devices and Circuit: An introduction | Goodyear Publishing Co. New Delhi ISBN: 9780876202654                                  |
| 5     | Horowitz, Paul Hill, Winfield                   | The Art of Electronics                          | Cambridge University Press, New Delhi 2015 ISBN: 9780521689175                         |
| 6     | Bell, David                                     | Fundamentals of Electronic Devices and Circuits | Oxford University Press, International edition, USA,2015,ISBN:9780195425239            |
| 7     | Vijay Baru, Rajendra Kaduskar, Sunil T. Gaikwad | Basic Electronic Engineering                    | Dreamtech press,New Delhi,2015,ISBN:9789350040126                                      |

### XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal   | Description                         |
|-------|---|-------------------------------------|
| 1     | <a href="https://www.youtube.com/watch?v=Fwj_d3uO5g8">https://www.youtube.com/watch?v=Fwj_d3uO5g8</a> | Diodes                              |
| 2     | <a href="http://www.eleccircuit.com">http://www.eleccircuit.com</a>                                   | Electronic circuit                  |
| 3     | <a href="https://www.electroschematics.com/tools/">https://www.electroschematics.com/tools/</a>       | Electronic tools                    |
| 4     | <a href="http://www.futurlec.com">www.futurlec.com</a>  | Electronic tools/components         |
| 5     | <a href="http://www.alldatasheet.com">www.alldatasheet.com</a>  | Datasheets                          |
| 6     | <a href="http://www.nptel.iitm.ac.in">www.nptel.iitm.ac.in</a>  | Electronic circuits                 |
| 7     | <a href="http://www.electronics-tutorials">www.electronics-tutorials</a>                              | Electronic circuits                 |
| 8     | <a href="https://www.learningaboutelectronics.com/">https://www.learningaboutelectronics.com/</a>     | Voltage Regulator                   |
| 9     | <a href="https://www.animations.physics.unsw.edu.au/">https://www.animations.physics.unsw.edu.au/</a> | Electronic tools/components/Circuit |