**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**

**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester-II

**Course Title: Basic Electronics**

(Course Code: C4322402)

| Diploma programmer in which this course is offered | Semester in which offered |
|---|---|
| Power Electronics | Second |

## 1. RATIONALE

This course will enable students to develop the skills required to use basic electronic components in various electronic circuits. Through the study of this course the students will get the knowledge of construction, working principle, characteristics and application of various types of semiconductor diodes and transistors. This course will develop skills to identify and test electronic components and design simple electronic circuits such as filters and DC Voltage regulator used for various applications.

## 2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Build an electronic circuits consisting of active electronic components.**

## 3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

CO 1) Use different types of diodes in various electronic circuits.
CO 2) Analyze various transistor configurations.
CO 3) Troubleshoot various single phase transistor amplifiers.
CO 4) Use passive filters and DC voltage regulators for various applications.
CO 5) Dispose electronic waste safely.

## 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme (In Hours) | | | Total Credits (L+T+P/2) | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | Total Marks |
| L | T | P | C | CA | ESE | CA | ESE | |
| 4 | - | 2 | 5 | 30 | 70 | 25 | 25 | 150 |

*(*): For this practical only course, 25 marks under the practical CA has two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15 marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

## 5. SUGGESTED PRACTICAL EXERCISES

*Following practical outcomes (PrOs) that are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|---|---|---|---|
| 1 | Test the performance of PN junction diode and obtain forward Bias and reverse bias characteristics. | I | 02* |
| 2 | Build and test the half wave rectifier. | I | 02* |
| 3 | Build and test the full wave rectifiers. | I | 02* |
| 4 | Build and test positive/ negative clipper circuit. | I | 02* |
| 5 | Build and test positive/ negative clamper circuit. | I | 02 |
| 6 | Build and test zener diode voltage regulator. | I | 02* |
| 7 | Test the performance of LED and Opto-coupler. | I | 02 |
| 8 | Test common emitter transistor configuration and obtain the value of current gain and input impedance. | II | 02* |
| 9 | Test common base transistor configuration and obtain the value of current gain and input impedance. | II | 02* |
| 10 | Test common collector transistor configuration and obtain the value of current gain and input impedance. | II | 02 |
| 11 | Test the performance of transistor as a switch | II | 02* |
| 12 | Test voltage divider bias technique. | III | 02* |
| 13 | Build and test base biased amplifier and obtain the value of voltage gain for given ac input signal. | III | 02* |
| 14 | Build and test emitter biased amplifier and obtain the value of voltage gain for given ac input signal. | III | 02* |
| 15 | Test the performance of full wave rectifier with shunt capacitor filter and series inductor filter. | IV | 02* |
| 16 | Build and test series and shunt voltage regulator using transistor. | IV | 04* |
| 17 | Test 7805,7812,7905,7912 regulator ICs. | IV | 02 |
| 18 | Testing of diode and transistor using multimeter | I,II | 01 |
| | **Minimum 14 Practical Exercises** | | **28 Hrs.** |

***Note***

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

| S. No. | Sample Performance Indicators for the PrOs | Weightage in % |
|---|---|---|
| 1 | Prepare of experimental setup | 20 |
| 2 | Operate the equipment setup or circuit | 20 |
| 3 | Follow safe practices measures | 10 |
| 4 | Record observations correctly | 20 |
| 5 | Interpret the result and conclude | 30 |
| **Total** | | **100** |

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 1 | Dual variable DC power supply ,0- 30V, 2A, With Short circuit protection, separate display for voltage and current | 1,2,3,4,5,6,7,8 ,9,10,11,12,13 ,14,15,16,17 |
| 2 | Discrete Component Trainer/ Analog component Trainer: 2mm patch cords in interconnecting components, Collection of utilities like fixed and variable D.C. supplies, electrical Components like, LDR, Transistor, Photo diode, IC 78XX, IC 79XX resistors, capacitors, inductors, LED's, Built in variable DC supply dual ± 0 to 15V/ 500mA, fixed DC power supply, ± 12V / 500 mA, fixed DC power supply +5V/500mA, Built in AC supply. | 1,6,7,17 |
| 3 | Digital Multimeter: 3 1/2 digit display, 1999 count digital multimeter measures: $V_{ac}$, $V_{dc}$ (600V max), 10Amp, Resistance ( 0 – 2 Mega Ohm) , with diode and transistor tester. | 1,2,3,4,5,6,7,8 ,9,10,11,12,13 ,14,15,16,17,1 8 |
| 4 | Digital Storage Oscilloscope, 2-channel/ 4-channnel models with 50 MHz to 200 MHz bandwidth. | 1,2,3,4,5,6,8,9 ,10,12,13,14,1 5 |
| 5 | Experimentation With Rectifiers kit: Transformer Rating : 9V center tapped (300mA)approximate, Half wave Rectifier output : +4V DC approximate, Center-Trapped Rectifier : +8V DC approximate. Bridge Rectifier Output : +8V DC approximate Filter : LC Type, Load : Resistive 220W, 0.5W, Mains Supply : 230V ±10%, 50Hz. Dimensions (mm) : W 250 x D 150 x H 80 Transformer Rating : 9V center tapped (300mA), approximate, Half wave Rectifier output : +4V DC approximate, Center-Trapped Rectifier : +8V DC approximate. Bridge Rectifier Output: +8V DC approximate, Filter: LC Type. Load : Resistive 220W, 0.5W,Mains Supply : 230V ±10%, 50Hz | 2,3,4,5 |
| 6 | Clipper and Clamper Trainer; Mains Supply: 230 V ±10%, 50 Hz Sine Wave Generator: 1 KHz, 15V Vpp (approx.) DC Power Supply: 0 - 5 V (vary through (2No.) rotary switch for specific voltage level). | 4,5 |

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 7 | Experimentation with Zener Diode Voltage Regulator; Transformer : 0 - 9V, 500mA (approximate) Filter : Capacitive 1000µF, 35V Zener Diode : Vz = 5.6V I = 178mA ZM Potentiometer, P1 : 4.7kW Potentiometer, P2 : 4.7kW Mains Supply : 230V ±10%, 50Hz. | 6 |
| 8 | Characteristics of Transistor (CB,CC,CE) Trainer: Fixed DC Power Supply : +5V, -5V, +12V, -12V,Variable DC Supply : ±1.5V to ±11V Transistor: BC547, BC557, Ammeter Range: 1µA to 200mA Display: 3½ digits. Voltmeter Range: 1mV to 200V Display: 3½ digit Mains: 230V AC ±10%. | 8,9,10 |
| 9 | Transistor as a Switch Experiment Board: Built in 5V DC power supply, On board test points to observe signals, transistor -1 Nos (BC 547), resistor- 2Nos ( 1k,10k). | 11 |
| 10 | Analog Circuits Development Platform: Size of Breadboard : 172.5mm x 128.5mm Tie Points on Breadboard : 1685 nos (solder less) DC Power Supplies : +5V, 1A (fixed) +12V, 500 mA (fixed) -12V, 500 mA (fixed) +12V, 500 mA (variable) -12V, 500 mA (variable) AC Supply : 9V-0V-9V, 500 mA Function Generator : Sine, Square, and Triangular functions Frequency range:1Hz to 100KHz In 5 steps (variable in between the steps) Modulation Generator : Sine, Square, and Triangular functions Frequency range:1Hz to 10KHz In 4 steps (variable in between the steps) Continuity Tester : For testing the continuity (provided with beeper sound) Mains Supply : 110-220V ±10%, 50/60Hz Accessories: Breadboards (solderless) : 2 nos Connecting wires : 20 nos 2mm to 1mm patch cords : 8 nos 2mm to 2mm patch cords : 8 nos Mains cord : 1 no. | 12,13,14,15,16 |
| 11 | Transistor Shunt Voltage Regulator Experiment Board and Trainer Kit. | 16 |
| 12 | Transistor Series Voltage Regulator Experiment Board and Trainer Kit. | 16 |

## 7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical instruments and tools.
c) Practice environmentally friendly methods and processes.(Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

## 8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at Application and above level) | Topics and Sub-topics |
|---|---|---|
| **Unit – I P-N Junction Diode, Applications and Special Purpose Diodes.** | 1a. Describe semiconductor material characteristics. | 1.1 Semiconductor Material: Germanium, silicon, atomic structure and characteristics of semiconductor material. |
| | 1b. Explain the working of P-N junction diode. | 1.2 P-N junction Diode: Symbol, Forward and Reverse biased characteristics. |
| | 1c. Explain the working of diode rectifier circuits. | 1.3 Rectifiers: half wave and full wave – centre tapped and bridge rectifier for R load. |
| | 1d. Troubleshooting and reading a datasheet of P-N junction diodes. | 1.4 Troubleshooting: Troubleshooting of P-N junction diode using ohm meter and multimeter.<br>1.5 Reading a Data Sheet: Reverse Breakdown Voltage, Maximum Forward Current, Forward Voltage Drop, Maximum Reverse Current. |
| | 1e. Analyze Diode clipper and clamper Circuits. | 1.6 Diode clipper: positive negative clipper<br>1.7 Diode clamper: positive and negative clamper. |
| | 1f. Explain working of Zener diode. | 1.8 Zener diode: forward and reverse characteristics, Zener diode as voltage regulator. |
| | 1g. Explain working of Light Emitting diode. | 1.10 LED: voltage and current through LED, Applications. |
| | 1h. Explain working of Photo diode and Opto-coupler (Opto-isolator) | 1.11 Photo diode: symbol, working principle<br>1.12 Opto-coupler: working principle, Applications. |
| | 1i. Explain working of Schottky diode. | 1.13 Schottky diode: working principle, applications. |
| **Unit– II Bipolar** | 2a. Explain construction and working of bipolar transistor. | 2.1 Construction, types- NPN, PNP. Basics of unbiased transistor. |

| Unit | Unit Outcomes (UOs)<br>(4 to 6 UOs at Application and above level) | Topics and Sub-topics |
|---|---|---|
| **Junction Transistor** | 2b. Reading a datasheet and Transistor Troubleshooting | 2.2 Reading a datasheet: Breakdown Ratings, Maximum Current and Power, Derating Factor.<br>2.3 Troubleshooting: Transistor Troubleshooting using multimeter. |
| | 2c. Explain various transistors configurations.<br>2d. Compare various transistors configurations. | 2.4 Biased transistor-<br>Common Emitter Configuration:<br>Common Base Configuration,<br>Common Collector Configuration, Comparison between CE, CB and CC configuration.<br>2.5 Current gain- β and α, relation between β and α. |
| | 2e. Describe the load line and operating point. | 2.6 The DC load line and operating point. |
| | 2f. Understand working of transistor as a switch. | 2.7 Use of Transistor as a switch. |
| **Unit – III Transistor Biasing Circuits and Single stage Transistor Amplifiers.** | 3a. Explain different types of biasing circuits. | 3.1 Importance of biasing.<br>3.2 Bias: fixed bias, collector to base bias, emitter bias and voltage divider bias |
| | 3b. Troubleshooting Voltage divider bias circuit | 3.3 Troubleshoot Voltage Divider Bias circuit by measuring Vb, Vc and Ve. |
| | 3c. Classification of amplifiers. | 3.4 Classification of amplifier according to use, frequency, coupling method and mode of operation. |
| | 3d. Understand practical circuit of single stage transistor amplifier circuit. | 3.5 Practical circuit:<br>Basic principal, geographical demonstration, Role of biasing circuit, input capacitor, bypass capacitor, coupling capacitor, Calculate various currents.<br>3.6 phase reversal in amplifier circuit, impedance and input output phase relationship.<br>3.7 DC and AC equivalent circuit of practical amplifier, DC and AC load line.<br>3.8 Calculation of voltage gain of Base biased and Emitter biased amplifier. |
| | 3e. Explain commonly used | 3.9 Transistor Amplifier: Base biased |

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at Application and above level) | Topics and Sub-topics |
|---|---|---|
| | transistor amplifier circuits. | amplifier, Emitter biased (with voltage divider biased) amplifier. |
| **Unit– IV Passive Filter and D.C. Voltage Regulator** | 4a. Justify the need for filters.<br>4b. Compare the different types of filter. | 4.1 Filters: types of filters- series L filter shunt C filter chock input filter, π filter. |
| | 4c. Justify need of Regulated DC Power supply<br>4d. Explain Transistorized Voltage regulators in electronic circuits.<br>4e. Select relevant regulator for specific applications. | 4.2 Limitations of Ordinary power supply and Need of regulated power supply<br>4.3 Series voltage regulator, shunt regulator using transistor.<br>4.4 Three terminal IC voltage regulators: 7805, 7812, 7905, 7912. |
| **Unit– V Handling Electronic Waste** | 5.a Justify the need of electronic waste methods.<br>5.b Establish the relationship between sustainability and electronic waste.<br>5.c Suggest methods of handling electronic waste with examples.<br>5.d Suggest methods to dispose electronic waste. | 5.1 Concept of electronic waste.<br>5.2 Sustainability and electronic waste management<br>5.3 Methods to handle electronic waste<br>5.4 Strategies of electronic waste management in the small electronics Industries |

***Note**: The UOs need to be formulated at an 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A Level | Total Marks |
| I. | P-N Junction Diode, its Applications and Special Purpose Diodes. | 18 | 4 | 8 | 10 | 22 |
| II. | Bipolar Junction Transistor | 9 | 3 | 5 | 5 | 13 |
| III. | Transistor Biasing Circuits and Single stage Transistor Amplifiers. | 15 | 4 | 7 | 9 | 20 |
| IV. | Passive Filter and D.C. Voltage Regulator | 9 | 2 | 4 | 4 | 10 |
| V. | Handling Electronic Waste | 5 | 1 | 2 | 2 | 05 |
| **Total** | | **56** | **14** | **26** | **30** | **70** |

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at*

*different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

## 10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare a table and interpret the technical specification of various diodes and transistors using data sheet.
b) Prepare specifications of inductor and capacitor used for passive filter.
c) Undertake a market survey for special purpose diodes.
d) Prepare a survey report different electronic waste management adopted by the local electronics industry.
e) Undertake a visit to e-waste handling plant nearby and prepare a report.

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.11***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students for finding proper active and passive components using datasheet manuals and websites for electronic application
g) Guide students on how to address various issues of e-waste on environment.

## 12. SUGGESTED MICRO-PROJECTS

**Only one micro-project** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **14-16 (fourteen to sixteen) student**

**engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build a full-wave center tap and bridge rectifier circuit with passive filters on PCB.
b) Build positive/negative clipper circuit on PCB/Breadboard.
c) Build positive/negative clamper circuit on PCB/Breadboard.
d) Build DC voltage regulator using Zener diode on PCB/Breadboard.
e) Build single stage voltage divider biased transistor amplifier.
f) Prepare a report of strategies regarding handling of electronic waste with figures, tables and comparative charts.

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication with place, year and ISBN |
|---|---|---|---|
| 1 | Principles of Electronics | V.K.Metha, Rohit Mehta. | S. Chand, New Delhi, 2014, ISBN: 978-8121924504 |
| 2 | Electronic Principles | Albert Paul Malvino. | McGraw Hill Education, ISBN 978-0-07-337388-1 |
| 3 | Electronic devices and circuit theory | Boylestad, Robert Nashelsky, Louis | pearson india ISBN 978-1-292-02563-6 |
| 4 | Solid and Liquid Waste Management Waste to Wealth | Rajaram, Vasudevan, Siddiqui Faisal Zia , Agrawal Sanjeev | PHI Learning Pvt. Ltd. New Delhi ISBN: 9788120352452 |
| 5 | E-Waste: Management and Procurement of Environment | Suresh Kumar, Jatindra Kumar Pradhan | Authors press 2021, ASIN : B095PR6MVS |

## 14. SOFTWARE/LEARNING WEBSITES

a) https://www.vlab.co.in
b) https://www.electronics-tutorials.ws
c) https://www.electronicshub.org/types-of-diodes
d) https://nptel.ac.in
e) www.electronicsforu.com
f) https://www.digikey.in/en/articles/transistor-basics
g) https://www.elprocus.com/transistors-basics-types-baising-modes/
h) https://learn.sparkfun.com/tutorials/transistors/all
i) www.alldatasheet.com

## 15. PO-COMPETENCY-CO MAPPING

| Semester II | Electrical & Electronic Workshop (Course Code: C4322402) | | | | | | |
|---|---|---|---|---|---|---|---|
| | POs and PSOs | | | | | | |
| Competency & Course Outcomes | PO 1 Basic & Discipline specific knowledge | PO 2 Problem Analysis | PO 3 Design/ development of solutions | PO 4 Engineering Tools, Experimentation &Testing | PO 5 Engineering practices for society, sustainability & environment | PO 6 Project Management | PO 7 Life-long learning |
| **Competency** | **Build an electronic circuits consisting of active electronic components.** | | | | | | |
| CO 1) Use different types of diodes in various electronic circuits. | 3 | 2 | 2 | 3 | 1 | 1 | 2 |
| CO 2) Analyze various transistor configurations. | 3 | 1 | 1 | 1 | 1 | - | 1 |
| CO 3) Troubleshoot various single phase transistor amplifiers. | 3 | 2 | 2 | 3 | 2 | 1 | 2 |
| CO 4) Use passive filters and DC voltage regulators for various applications. | 3 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO 5) Dispose electronic waste safely. | 1 | 1 | 1 | 2 | 3 | 2 | 1 |

Legend: '**3**' for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

## 16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

**GTU Resource Persons**

| S. No. | Name and Designation | Institute | Contact No. | Email |
|---|---|---|---|---|
| 1. | Mr. Shailesh Dhoriyani, Lecturer – Power Electronics Department. | Dr. S. & S. S. Ghandhy college of engineering & Technology, Surat | 9913776990 | shailesh.dhoriyani@gmail.com |