GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC2021)
Semester-III

Course Title: Analog Electronics
(Course Code: 1336402)

Diploma program in which this course is offered	Semester in which offered
Renewable Energy	3rd semester

1. RATIONALE

At present, electronic gadgets are being extensively used in various manufacturing processes in industries, power system operations, communication systems, computers etc. Even for renewable energy diploma holder, it is absolutely necessary to have a basic understanding of electronic components, their function and applications. This understanding should facilitate in operation and maintenance equipment, which are electronically controlled. In this course, topics like Bipolar transistors, amplifiers and field effect transistors, Optoelectronics, Oscillators, Op-amp and it's application have been included.

Analogue electronic components and circuits are building blocks for any electronic device used in industries or in daily life. It is therefore necessary for engineers to understand clearly the principles and functioning of the basic analogue components and circuits. This course will enable the students to understand the basics of construction, working, and applications of various types of electronic components such as BJT, FET, MOSFET and Amplifier circuits such as feedback amplifier, oscillators and operational amplifier using linear ICs. Practical exercises of this course would enable students to maintain such circuits and in turn maintain equipment having such circuits. This course is therefore one of the basic core courses which is must for every renewable energy engineer and hence should be taken very sincerely by students. This course will enable the students to learn about the use of transistors in analog circuits like Transistor, amplifier, oscillators and Optoelectronics devices etc. It also gives information about operational amplifier, voltage regulator, ICs and their applications for effective functioning in the field of electronic service industry.

2. COMPETENCY

The course content should be taught and with the aim to develop different types of skills so that students are able to acquire following competency :

- Maintain various types of analog electronic components and circuits.
- Test the different electronic components and circuits.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Apply knowledge of transistor in various amplifier circuits.
b) Use the different types of oscillator.
c) Identify the behavior of opto electronic devices
d) Use of Regulated power supply for various industrial needs.
e) Analyze different types of circuits using operational amplifier IC 741.

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(M)	ESE(E)	CA(I)	ESE(V)	
3	0	2	4	*30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) 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'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Test transistor as a switch	1	2
2	Test the performance characteristics of CB transistor amplifier.	1	2*
3	Test the performance characteristics of CE transistor amplifier.	1	2*
4	Test the characteristics of small signal amplifier using FET.	1	2
5	Build and test MOSFET as an amplifier	1	2

6	Build/Test Hartley oscillator using CRO.	2	2*
7	Build/Test Colpitts oscillator using CRO.	2	2*
8	Build/Test RC Phase Shift Oscillator.	2	2
9	Test characteristics of LDR.	3	2
10	Test characteristics of LED	3	2
11	Display various alphanumeric characters on Seven segment LED Display.	3	2*
12	Build voltage regulator using 78XX and 79XX and measure the drop out voltage for the given voltage regulator.	4	2
13	Test the performance of SMPS.	4	2*
14	Test the performance of UPS.	4	2
15	Identify the pins of IC741	5	2
16	Test the characteristics of IC741.	5	2*
17	Build inverting amplifier using Op-Amp and observe input, output waveforms on CRO.	5	2
18	Build non-inverting amplifier using Op-Amp and test its performance using the CRO.	5	2
19	Build/test Op-Amp as summing amplifier.	5	2*
20	Build/test Op-Amp as scaling amplifier.	5	2
21	Build/test Op-Amp as an averaging amplifier.	5	2
22	Build/test Op-Amp as an Integrator	5	2*
23	Build/test Op-Amp as a differentiator	5	2*
24	Build/test Comparator circuit using Op-Amp.	5	2
	Minimum10 Practical Exercises		28

Note:

a) *More Practical Exercises can be designed and offered by there respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

b) *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.*

Sr.No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare and operate experimental setup	30
2	Follow safe practices	10
3	Record observations correctly	20
4	Interpret the result and conclude	20
5	Quality of Answer related to experiment(Q&A)	20
Total		**100**

6. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

This major equipment 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.

Sr. No.	Equipment Name with Broad Specifications	PrOs No.
1	Regulated power supply: Dual DC , 0-30V/1A & 5V /1A with resolution of 10mV , 2mA	1-13, 16-24
2	Digital Storage Oscilloscope : 300 MHZ Bandwidth , 2GSa/s maximum real time sampling rate refresh rate upto 2000 wfams/s , RS232 & USB connectivity	6,7,17,18,22,23,24,
3	Function generator: 10 HZ to 10MHZ , 10 Vpp , rise & fall time =20ns, manual / external triggering	17,18,22,23
4	Digital Multimeter: 51/2 digits resolutions with all basics measurement facility like DC Voltage: 200 mV ~ 1000 V, DC Current: 200 µA ~ 10 A, AC Voltage: True-RMS, 200 mV ~ 750 V, AC Current: True-RMS, 20 mA ~ 10 A, 2-Wire, 4-Wire Resistance: 200 Ω ~ 100 MΩ, Capacitance Measurement: 2 nF ~ 10000µF, Frequency Measurement: 20 Hz ~ 1 MHz etc., 0.015% DC Voltage Accuracy	1-13, 16-24

5	DC Ammeter(0-50mA, 0-500 µA)	1-13,16-24
6	DC Voltmeter (0-30V, 0-10V)	1-13,16-24
7	C.R.O.:50MHz Bandwidth,2 channels, 20 ns sampling time	6,7,17,18, 22,23
8	Experimental Trainer Kits, Bread Board, General Purpose PCB, active and passive components	1-24

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 course competency.

a) Work as a leader/a team member(while doing a micro-project).
b) Follow ethical practices.
c) Work as a group member (while performing experiments and taking readings).
d) Practice environmental friendly methods and processes. (Environment related).

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level ofachievementoftheADOsaccordingtoKrathwohl's'AffectiveDomainTaxonomy'shouldgraduallyincreaseas planned below:

I. 'ValuingLevel'in1st year
II. 'OrganizationLevel'in2nd year.
III. 'CharacterizationLevel'in3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the Cos and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes(UOs)	Topics and Sub-topics
Unit I: Transistors and MOSFETs	1a. Describe Concept of junction transistor, PNP and NPN transistors and mechanism of current flow. 1b.ExplainTransistor configurations: common base (CB), common emitter (CE) and common collector (CC), current relation and their characteristics; 1c. Compare CB,CE and CC configurations. 1d. Describe working of Transistor as a switch and it's application. 1e. Explain application of Transistor as an amplifier. 1f. Explain construction and working of MOSFET. 1g. Compare BJT and MOSFET.	1.1 Formation of a transistor: 1.1.1 PNP & NPN transistor with symbol 1.1.2 Leakage current in a transistor 1.1.3 Relationship between alpha & beta. 1.2 Transistor Configuration: 1.2.1 Common Base(CB) Configuration 1.2.2 Common Emitter(CE) Configuration 1.2.3 Common Collector(CC) Configuration. 1.3 Transistor Characteristics: 1.3.1 Input/output Characteristics of CB 1.3.2 Input/output Characteristics of CE 1.4 Comparison of the CB, CE, CC Configurations. 1.5 Transistor as a switch: working and it's application. 1.6 Transistor as an amplifier(CE configuration only). 1.7 FET- definition, types. MOSFET- definition, types, symbols. 1.8 N type enhancement mode- construction and working of MOSFET. 1.9 MOSFET characteristics. 1.10 Applications of MOSFET. 1.11 Comparison between BJT and MOSFET.

Unit: II Oscillators	2.a Explain the working of different types of oscillators with relevant sketches. 2.b select oscillator for different frequency generation.	2.1 Principle of oscillators 2.2 Classification of oscillators 2.3 LC Oscillator: Working, Types, Applications 2.3.1: Hartley Oscillator: Circuit diagram and it's working. 2.3.2: Colpitts Oscillator: Circuit diagram and it's working. 2.3.3: Comparison between Hartley and Colpitts Oscillator. 2.4 RC Oscillator: Principle, Types 2.4.1: RC Phase shift Oscillator: Circuit diagram and it's working.
Unit-III: Opto-electronic devices	3a. Describe working of the photo diode with symbol. 3b. Explain construction and working of photo transistor. 3c. Explain construction and working of LDR. 3d. Explain construction and working of LCD and LED. 3e.Explain seven segment LED display 3f.Describe opto-coupler with symbols.	3.1 Photo diode: Symbol, construction, working, advantages, disadvantages and it's application. 3.2 Photo Transistor: Symbol, construction, working, advantages, disadvantages and it's application. 3.3 Light Dependent Resistor(LDR): Symbol, construction ,working, advantages, disadvantages and it's application. 3.4 Liquid Crystal Display: Construction, working, advantages, disadvantages and it's application. 3.5 Light Emitting Diode(LED):Symbol, construction ,working, advantages, disadvantages and it's application.

		3.6 Seven segment LED display. 3.7 Opt coupler: Function, Importance of Optocoupler, Construction, advantages, disadvantages and it's application.
Unit: IV Regulated DC Power Supplies	4a.Explain Regulated DC power supply 4b. Describe Concept of fixed and variable voltage regulator 4c.Explain working of SMPS 4d. Explain working of UPS.	4.1 Concept of DC power supply. Line and load regulation 4.2 Concept of fixed voltage regulators (IC 7805, 7905) and adjustable voltage regulator using LM317 4.3 Switch mode power supply: Block diagram, advantages, disadvantages and it's application. 4.4 Uninterruptible power supply: working of UPS.
Unit:V Linear Integrated Circuits	5a Explain working of operational amplifier with block diagram. 5b. Describe Op-amp Equivalent Circuit.	5.1 Operational amplifier 5.2 Block diagram representation of a Typical Op-amp. 5.3 The Ideal Op-amp. 5.4 Equivalent circuit of an Op-amp
	5c. Identify the pin specifications and voltage levels of IC 741 in the given sketch, 5d. Explain the open and closed loop concept in Op-amps	5.5 IC-741 and its pin configuration 5.6 Op-Amp: concept of open loop and closed loop amplifier
	5e.Explain the parameters of operational amplifier . 5 f. Describe the characteristics of ideal op-amplifier.	5.7 Op-Amp parameters: Input and output offset voltage, Input offset current, Input bias current, differential voltage gain, CMRR, slew rate, PSRR. 5.8 Characteristics of an ideal op-amp.

	5g. Explain inverting & non inverting amplifiers using operational amplifier 5h. Describe Summing, Scaling and Averaging amplifier using op-amplifier. 5i. Describe Integrator, differentiator using op-amplifier. 5j. Explain Op-Amp as comparator.	5.9 Inverting and non-inverting amplifier using Op-amp. 5.10 Summing, Scaling and Averaging amplifier, integrator, differentiator, comparator.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	UnitTitle	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Transistors and MOSFETs	10	7	5	5	17
II	Oscillators	06	3	3	4	10
III	Optoelectronic devices	06	3	4	3	10
IV	Regulated Power Supply	06	3	4	3	10
V	Linear integrated circuits	14	8	7	8	23
	Total	42	24	23	23	70

Legends:*R=Remember,U=Understand,A=Applyandabove(RevisedBloom'staxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to 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 slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

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

a) Present seminar on various topics from course content.
b) Prepare specification of electrical and electronic components.
c) Test different semiconductor devices using multi-meter.
d) Undertake market survey for different electrical and electronics systems.
e) Design and construct simple application such as door bell/calling bell, blinking LED, burglar's alarm etc. Prepare a report on its design, function, specifications and cost estimation.
f) Collect the technical specifications and price of at least 10 electronic components such as transistor, MOSFET etc. and at least 5 electronics equipments such as UPS, CRO etc.
g) Prepare chart for characteristics of various electronics components.
h) Survey to collect data sheets for various electronics components used in different circuits.
i) Student visit library to refer to Electronic Journals.
j) Student visits the Lab to construct the circuits on a bread board.
k) Ask the students to purchase different electronic devices from a shop.
l) Making use of online simulation laboratories.
m) Group discussion.
n) Under take micro-projects in teams.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES(if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various out comes 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'insectionNo.4*** meansdifferenttypesofteachingmethodsthataretobeemployedbyteachersto develop the outcomes.
d) Show animation/video related to course content.
e) Some of the topics/sub-topics which are relatively simpler or descriptive are to be given to the students for self-learning but to be assessed using different assessment methods.
f) Correlatingtheimportanceofthecontentofthiscoursewithothercourses/practicalapplications.
g) Guide students for using data manuals.
h) Guide students on how to address issues on environment and sustainability.

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-projects are 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 infact, an integration no 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) Prepare chart of comparison of CB, CE and CC transistors.
b) Prepare chart of amplifier with positive feedback as oscillator
c) Make a circuit of Burglar alarm using LDR.
d) Design and construct simple application such as door bell/calling bell, blinking LED, burglar's alarm etc. Prepare a report on its design, function, specifications and cost estimation.
e) Collect the technical specifications and price of at least 10 electronic components such as diode, transistor etc. and at least 5 electronics equipments such as RPS, UPS, CRO etc.
f) Prepare a report after visiting nearby electronics shop/market to identify the different Transistors and MOSFETs with their ratings.
g) Prepare a report after visiting nearby electronics shop/market and list different IC's for timers and OP-AMP applications.
h) Visit nearby Automobile show room and identify the optoelectronic devices and purpose.

13. SUGGESTEDLEARNINGRESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Op-Amps and Linear Integrated circuits	Ramakant A. Gayakwad	PHI, latest edition
2	Principle of Electronics	V.K. Mehta	S. Chand, New Delhi, latest edition
3	Electronic Principles	S.K. Sahdev	Dhanpat Rai & Co., New Delhi,2022
4	Semiconductor opto electronics devices	Pallab Bhattacharya	Prentice Hall of India Pvt. Ltd., latest edition
5	Electronics Principles	Malvino, Albert	TMH, New Delhi, latest edition
6	Applied Electronics.	R.S. Sedha	S Chand &co., latest edition.
7	Electrical Technology. Vol-IV	B.L.Theraja	S Chand &co., latest edition.
8	Fundamentals of Digital circuits	Kumar A. Anand.	PHI Learning, latest edition.
9	Electronics Principles and applications	Charles A Schuler and Roger L Tokhiem	Sixth Edition, Mc. Graw Hill , 2008
10	Electronics Devices and Circuits	AllanMottershed	PHI Learning Pvt. Ltd., First Edition
11	Electronics Analog and Digital	I. J. Nagrath,.	PHI Learning Pvt. Ltd., 2013 Edition
12	Electronic Devices and Circuits	S. Salivahanan , N. Sereshkumar	McGraw Hill Education (India) Private Limited, ISBN - 9781259051357
13	Electronic Devices and Circuits	David A. Bell	Oxford University Press, ISBN-9780195693409
14	Electronic Devices and Circuits	Robert Boylestad	PHI, New Delhi, latest edition.
15	Electronics fundamental and application	Chattopadhyay,D.	New Age International publishers, latest edition.

14. SOFTWARE/LEARNINGWEBSITES

(1) www.nptel.iitm.ac.in
(2) https://ndl.iitkgp.ac.in
(3) www.electrical4u.com
(4) www.vlab.co.in
(5) https://nptel.ac.in/courses/108/105/108105112/
(6) https://lectures.gtu.ac.in/(relatedtocoursecontent)
(7) https://www.electricaltechnology.org/
(8) https://circuitmaker.com/
(9) https://www.allaboutcircuits.com/
(10) www.faculty.virginia.edu/stt/...5.../pdfFiles/SemiconductorsDiodes.pdf
(11) www.youtube.com/watch?v=xzVDMUMW9JU
(12) http://www.allaboutcircuits.com/
(13) http://www.allaboutcircuits.com/videos
(14) Electronics work bench
(15) Circuit maker
(16) pSpice
(17) www.allaboutcircuits.com
(18) www.howstuffwork
(19) www.kpsec.freeuk.com
(20) www.electrical-electronics.org

15. PO-COMPETENCY-COMAPPING:

Semester III	**Fundamental Of Electrical and Electronics Engineering (CourseCode:1326401)**						
	Pos						
Competency &CourseOutcomes	PO1 Basic& Disciplinespecific knowledge	PO2 ProblemAnalysis	PO3 Design/development ofsolution	PO 4 EngineeringTools,Experimentation&Testing	PO 5 Engineeringpractices forsociety, sustainability&environment	PO6 Project Manage-ment	PO7 Life-longlearning
Competency	• **Maintain various types of analogue electronic components and circuits.** • **Test the different electronic components and circuits.**						

Course Outcomes CO-1 Apply knowledge of transistor in various amplifier circuits.	3	2	-	2	-	-	-
CO-2 Use the different types of oscillator.	3	-	2	2	-	-	-
CO-3 Identify the behavior of opto electronic devices.	3	2	-	2	-	2	-
CO-4 Use of Regulated power supply for various industrial needs.	2	-	-	2	-	-	-
CO-5 Analyze different types of circuits using operational amplifier IC 741.	2	2	2	2	-	-	-

*Legend:'**3'** forhigh,'**2**'formedium,**'1'**forlowand **'-'**for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	NameandDesignation	Institute	ContactNo.	Email
1.	Dipa J. Kapupara Lecturer-Electrical Engg.	AVPTI, Rajkot	9409111405	Dipakapupara.ee@gmail.com

2.	M.M.Dalwadi Lecturer-EC Engg.	Government Polytechnic, Jamnagar	9825973163	Mitesh.ec14@gmail.com