GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

LINEAR ELECTRONIC CIRCUITS
(Code: 3332405)

Diploma Programme in which this course is offered	Semester in which offered
Power Electronics	3rd semester

1. RATIONALE

Operational amplifier is one of the most common electronic circuits in most electronic equipment. To maintain linear electronic circuits, it is essential to test the performance of operational amplifiers. Hence, this course deals with all those aspects of operational amplifiers with positive and negative feedback for various configurations. Therefore, undertaking this course will help to maintain the linear electronics circuits comprising of the operational amplifiers.

2. COMPETENCY (Programme Outcome according to NBA Terminology)

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

- **Maintain linear electronic circuits comprising of operational amplifiers.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Introduction to Operational Amplifiers	1a. Identify various types of ICs and packages.	1.1 Linear Integrated circuits: classification, packages, pin identification, temperature range and other parameters.
	1b. Explain the working of differential amplifier	1.2 Amplifier: transistor differential pair, differential amplifier with constant current bias.
	1c. Describe the block diagram of Op-amplifier.	1.3 Operational amplifier: definition, block diagram, schematic symbol, current mirror concept
Unit – II Performance of Op-Amps	2a. Define the parameters of OP-AMPS.	2.1. Opamp Parameters: input offset voltage, and current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, supply voltage rejection ratio, large signal voltage gain, output voltage swing, output resistance, output short circuit current, supply current, power consumption, transient response, slew rate, gain bandwidth product, average temperature coefficient of input offset voltage and current, noise
	2b. Describe the characteristics of ideal opamps.	2.2. Opamp: Characteristics of ideal op-amp, equivalent circuit, virtual ground.
	2c. Explain the working of inverting and non-inverting types of opamps configurations. **2d.** State the steps to test the performance of opamps	2.3. Open loop configuration: inverting, non-inverting opamps
Unit – III Op-Amp with Negative Feedback	3a. Explain working of voltage series feedback amplifier.	3.1. Voltage series feedback: negative feedback, closed loop voltage gain, difference input voltage
	3b. Explain working of voltage shunt feedback amplifier.	3.2. Voltage shunt feedback: closed loop voltage gain, inverting input terminal at virtual ground, current to voltage converter, inverter
	3c. Explain the working of differential amplifiers.	3.3. Differential amplifier: with one opamp, two opamps
Unit – IV Linear Applications	4a. Differentiate between AC and DC amplifier	4.1. Amplifier: AC, DC, AC amplifier with single supply
	4b. Distinguish the working of Summing, Scaling and Averaging amplifier	4.2. Summing, scaling and averaging amplifier
	4c. Discriminate the working of	4.3. Voltage to current converter with

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	voltage to current converter, Integrator, Differentiator and instrumentation circuits.	grounded load, Integrator, differentiator, instrumentation amplifier.
Unit – V Comparators and Converters	5a. Select the relevant comparators for any given linear circuit	5.1. Comparator: characteristics, basic comparator, Zero crossing detector, Schmitt trigger and limitations.
	5b. Explain the working of Digital to Analog converter	5.2. Digital to analog converter: binary weighted, R- 2R
	5c. Describe the working of Analog to Digital converter	5.3. Analog to digital converter: successive approximation, continuous type.

5. SUGGESTED SPECIFICATION TABLE (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Operational Amplifiers	6	4	3	2	9
II	Performance of Op-Amps	8	2	8	4	14
III	Op-Amp with Negative Feedback	10	3	6	8	17
IV	Linear Applications	9	2	8	5	15
V	Comparators and Converters	9	4	7	4	15
Total		**42**	**15**	**32**	**23**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of ***Programme Outcomes/Course Outcomes in affective domain*** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA terminology)	Approx. Hrs. Required
1	I	Interpret the parameters of given Op-Amplifier.	1
2	I	Test differential transistor amplifier with constant current bias.	2

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA terminology)	Approx. Hrs. Required
3	II	Test open loop inverting amplifier.	1
4	II	Test open loop Non inverting amplifier.	1
5	II	Test open loop differential amplifier.	1
6	III	Test closed loop inverting amplifier.	1
7	III	Test closed loop non-inverting amplifier.	1
8	III	Test differential amplifier circuit using one op-amp.	1
9	III	Test differential amplifier using two op-amp.	2
10	IV	Test AC amplifier using single supply.	1
11	IV	Test Summing amplifier using inverting and non-inverting configuration.	2
12	IV	Test Averaging amplifier using inverting and non-inverting configuration.	2
13	IV	Test Subtractor using inverting, non-inverting and differential configuration of Op-amp.	2
14	IV	Test voltage to current converter.	2
15	IV	Test Integrator circuit and observe the output waveform.	2
16	IV	Test differentiator circuit and observe the output waveform.	2
17	V	Check the performance of zero crossing detector and observe the output waveform.	1
18	V	Determine the frequency of Schmitt trigger circuit and observe the output waveform.	2
19	V	Obtain the output of 4-bit D-A Converter circuit consist of op-amp as major component.	2
20	V	Measure the output of the A-D converter circuit consist of op-amp as major component.	2
		Total	**33**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i. Collect different datasheet of Op-Amp and list the parameter values that are affecting the operation of op-amp while operating.
ii. Make universal test board for op-amp to check the performance of various circuits build using op-amp and discrete components.
iii. Observe the output parameter values as well waveform using simulation and compare it with practical results.
iv. Make a comparative table for the comparison various op-amps parameters.

8. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation films on working of different types of Op-Amps.
ii. Give assignment/mini projects based on application of Op-Amps.

9. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Books	Author	Publication
1	Op-Amps and Linear Integrated Circuits	Gayakwad R. A.	PHI Learning, New Delhi, 2009, 4th edition or latest
2	Electronic devices and circuits	Gupta J. B.	S. K. Kataria & Sons, 2012, 3rd edition or latest
3	Op-Amps and Linear Integrated Circuits	Sharma sanjay	S. K. Kataria & Sons (2012), 2nd edition or latest
4	Linear Integrated Circuits and Applications	Bakshi U. A. , Godse A. P.	Technical Publications (2010), Pune, 1st edition or latest

B) List of Major Equipment/Materials with Broad Specifications

i. Digital multicenter(3-3/4 digit)
ii. Oscilloscope(50Mhz,2 channel)
iii. Function Generator(50Mhz)
iv. DC power supply(-30V-0-30V DC
v. Circuit boards/Educational Kits
vi. Breadboards, soldering station.

C List of Software/Learning Websites

i. PSIM
ii. CASPOC
iii. OrCAD
iv. http://www.electronics-tutorials.ws/opamp/opamp_1.html
v. http://educypedia.karadimov.info/electronics/electronicaopening.htm
vi. http://www.analog.com/library/analogDialogue/archives
vii. www.nptel.com

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. A. Patel**, LPE, Dept. of Power Electronics, Dr. S. & S. S. Ghandhy College of Engg. and Technology, Surat
- **Prof (Smt.) J. M. Patel**, ALPE, Dept. of Power Electronics, Dr. S. & S. S. Ghandhy College of Engg. and Technology, Surat

Coordinator and Faculty Members from NITTTR Bhopal

- **Anjali Potnis,** Assistant Professor, Department of Electrical and Electronics Engineering.
- **A.S. Walkey**, Associate Professor, Department of Electrical and Electronics Engineering.