COURSE TITLE	**ANALOG ELECTRONICS**
COURSE CODE	**01CT1113**
COURSE CREDITS	**4**

Objective:

1 Enable the students to have firm grasp of basic principles of analog circuits and primary focus on the common operational amplifier and linear integrated circuit configurations so that student is able to analyze and design wide variety of circuits that perform desired operations.

Course Outcomes: After completion of this course, student will be able to:

1 Analyze the technical specifications from opamp datasheet
2 Analyze the linear and nonlinear opamp based circuits
3 Apply the concepts of opamp in developing various circuits
4 Design opamp based circuits for real time applications.
5 Evaluate the effect of offset voltage and bias currents on opamp circuit accuracy.

Pre-requisite of course: Basics of Electronics Engineering

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Operational Amplifiers** Historical perspectives and need of basic DC amplifier, three transistor based prototype opamp circuit and its analysis, Block diagram of op-amp, Ideal op-amp characteristics, equivalent circuit of op-amp, open loop op-amp configurations, Reading and interpretation of op-amp data sheets, Various electrical characteristics of practical op-amp	6
2	**The Practical op-amp** Introduction, Input offset voltage and offset voltage compensating network design, Input bias current and input offset current, total output offset voltage, Thermal drift, Effect of variation in power supply voltages on offset voltage, Change in input offset voltage and input offset current with time, common mode rejection ratio, frequency response of op-amp, compensating networks, circuit stability, causes of slew rate and effect of slew rate in applications, calculations for error voltage, problems and analysis for various opamp based circuits	8

Contents : Unit	Topics	Contact Hours
3	**General Linear Applications** DC and AC amplifiers, summing, scaling and averaging amplifiers, instrumentation amplifier, Voltage to current converter with floating load, voltage to current converter with grounded load, current to voltage converter, integrator and differentiator, opamp based voltage regulator circuit designs, current transmitter circuit development using opamp	8
4	**Active filters and Oscillators** First order and second order low pass butterworth filter and its design, First order and second order high pass butterworth filter and its design, Band pass filters, Band reject filters, Oscillators and its principles, Phase shift oscillator, Square wave generator, triangular wave generator, sawtooth generator, voltage controlled oscillator	8
5	**Comparators and Converters** Basic comparator, zero crossing detector, Schmitt trigger, voltage limiters, Window detectors, Voltage to frequency and frequency to voltage converters, Analog to Digital converters, Digital to Analog converters, small signal rectifiers, absolute value output circuit, peak detector, sample and hold circuit, comparator characteristics and limitations of opamp as comparators, opamp based clippers and clampers	8
6	**Specialized IC applications** 555 timer, Monostable multivibrator, Astable multivibrator, phase locked loops, voltage regulators, fixed voltage regulators, adjustable voltage regulators, switching regulators	4
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment-1** Analyze the inverting and non-inverting op-amp configuration in open loop condition.	2
2	**Experiment-2** Analyze the working of closed loop op-amp in inverting mode of operation. Consider input signal is sinewave of 1V Peak amplitude. Set the gain of this circuit 10 and develop the frequency response for frequency range 1Hz to 100KHz.	2
3	**Experiment-3** analyze the working of closed loop op-amp in non inverting mode of operation. Consider input signal is sinewave of 1V Peak amplitude. Set the gain of this circuit 10 and develop the frequency response for frequency range 1Hz to 100KHz.	2
4	**Experiment-4** Develop inverting summing, scaling and averaging amplifier for three different inputs.	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
5	**Experiment-5** Develop non inverting summing, scaling and averaging amplifier for three different inputs.	2
6	**Experiment-6** Develop subtractor circuit using op-amp and verify with necessary input signals.	2
7	**Experiment-7** Design instrumentation amplifier using three op-amp. Verify the design with necessary input signals using bridge configuration to get difference signal.	2
8	**Experiment-8** Develop basic integrator and differentiator circuit using op-amp. Demonstrate the working principles of above circuits using square wave input signal.	2
9	**Experiment-9** Develop first order butterworth low pass filter and high pass filter. Verify the filter with necessary input signal and observing output response.	2
10	**Experiment-10** Develop square wave and triangular wave form generator using op-amp.	2
11	**Experiment-11** Analyze zero crossing detector circuit using op-amp as a comparator. With necessary input signal verify the output wave form.	2
12	**Experiment-12** Develop schmitt trigger circuit using op-amp and verify its operation.	2
13	**Experiment-13** Develop window detector circuit using op-amp and verify its operation.	2
14	**Experiment-14** . Develop precision rectifier circuit using op-amp and verify its operation using sine wave input signal for very low input voltage.	2
15	**Experiment-15** Design op-amp based voltage regulator circuit and verify it.	2
16	**Experiment-16** Design three transistor based opamp prototype and prove that it can work as a DC amplifier.	2
17	**Experiment-17** Design opamp based current transmitter circuits	2
Total Hours		**34**

MR. CHANDRASINH DHIRUBHA PARMAR
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Textbook :

1 Op-amps and Linear Integrated Circuits, Ramakant A. Gayakwad, Pearson Education, Fourth Edition, 2010

References:

1 Design with operational amplifier and Analog Integrated Circuits, Design with operational amplifier and Analog Integrated Circuits, Sergio Franco, McGraw Hill, Fourth Edition, 2012

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	10.00	30.00	30.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of the students. The teacher in addition to conventional teaching method (Chalk and Talk) may use any of the tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc. for effective teaching.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of the semester for evaluation of performance of students in laboratory.

4 Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.

5 The course delivery method will depend upon the requirement of content and need of the students. The teacher in addition to conventional teaching method (Chalk and Talk) may use any of the tools such as demonstration, role play, Quiz, brainstorming, Flipped class, Project based learning, Collaborative learning, MOOCs etc. for effective teaching.

Supplementary Resources:

1 Analog Circuits https://nptel.ac.in/courses/108101094

2 Analog ICs https://nptel.ac.in/courses/108106068

3 Electronics for Analog Signal Processing-I https://nptel.ac.in/courses/117106087

4 Electronics for Analog Signal Processing-II https://nptel.ac.in/courses/117106088

MR. CHANDRASINH DHIRUBHA PARMAR
Digitally signed by (Name of HOD)

DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)