ADVANCED ELECTRONICS
ENEX 202

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective of this course is to provide fundamental understanding of operational amplifiers, including their performance, limitations, and suitability for specific applications. Students will also learn to devise efficient techniques for energy transformation and regulation in power electronic circuits, and explore the principles and components of data conversion using DAC and ADC systems.

1 Operational Amplifier Characterization (9 hours)

1.1 Input offset voltage
1.2 Input bias and input offset currents
1.3 Output impedance
1.4 Differential and common-mode input impedance
1.5 DC gain, bandwidth, gain-bandwidth product
1.6 Common-mode and power supply rejection ratio
1.7 Higher frequency poles settling time
1.8 Slew rate
1.9 Noise in operational amplifier circuits

2 Digital-to-Analog and Analog-to-Digital Conversion (7 hours)

2.1 Performance parameters of DAC and ADC
2.2 Binary weighted resistor DAC
2.3 The R-2R ladder DAC
2.4 Unipolar and bipolar D/A converters
2.5 Count-up and tracking A/D's based on D/A's
2.6 Successive approximation A/D converters
2.7 Integrating voltage-to-time conversion A/D converters, dual and quad slope types
2.8 Sigma delta A/D converters
2.9 Flash A/D converters

3 Instrumentation and Isolation Amplifiers (4 hours)

3.1 One and two operational amplifier instrumentation amplifiers
3.2 The three operational amplifier instrumentation amplifier
3.3 Consideration of non-ideal properties

3.4 Isolation amplifier principles and realization
3.5 Consideration of non-ideal properties

4 Operational Amplifier-Bipolar Transistor Logarithmic Amplifier (4 hours)

4.1 The basic logarithmic amplifier
4.2 Non-ideal effects
4.3 Stability consideration
4.4 Anti-logarithmic operations

5 Log-Antilog Circuit Application (4 hours)

5.1 Analog multiplier based on log-antilog principles
5.2 The multifunction converter circuit
5.3 Proportional to absolute temperature (PTAT) devices
5.4 RMS to DC conversion

6 Power Electronics (11 hours)

6.1 Power diodes, power MOSFET V-I characteristics
6.2 Thyristor: V-I, turn on-off mechanism, protection schemes, firing circuits, series/parallel combination, self and forced commutation
6.3 Members of thyristor family: DIAC, TRIAC
6.4 Controlled rectifier circuits: single phase half wave and full wave with RLE load
6.5 Inverters: Fixed voltage variable frequency (half and full), variable voltage variable frequency (PWM inverters)
6.6 Choppers: Principle of operation, control strategies, step up chopper, classification of chopper circuits

7 Switched Mode Power Supplies and Drives (6 hours)

7.1 Switch mode power supply
7.2 Buck, boost, buck-boost regulator
7.3 DC drives: classification and choice of selection
7.4 Review of characteristics and operating modes of DC motors
7.5 Half wave and full wave single phase converters drives
7.6 Stepper motor and drives

Tutorial (15 hours)

1. Numerical related to input and output offset voltage, input bias current, determination of input output impedance of op-amp circuit, gain bandwidth product and slew rate limitation
2. Numerical related to DAC and ADC performance parameters and analog/digital conversion
3. Problems related to instrumentation amplifier
4. Problems related to log, antilog amplifiers and stability consideration

5. Application of log and antilod amplifiers and PTAT devices
6. Problems related to SCR, controlled rectifiers, inverters and choppers
7. Problems related to SMPs, BUCK-BOOST regulators, converters with DC motor and drives

Assignment

Appropriate assignment problems are given to students after the completion of each chapter.

Practical **(22.5 hours)**

1. Characteristics of Operational amplifier
2. 4-bit D to A converter
3. Differential and Instrumentation amplifiers
4. Logarithmic amplifiers, multipliers, RMS to DC conversion
5. Switched voltage regulator design
6. Silicon-controlled-rectifier (SCR) circuit design
7. Stepper Motor control with driver module and arduino

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	8	12
2	7	9
3	4	5
4	4	5
5	5	6
6	11	15
7	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Sedra, A. S., Smith, K. C. (2010). Microelectronic Circuits. United Kingdom: Oxford University Press.
2. Stanely W. (1987). Operational Amplifiers with Linear Integrated Circuits. Charles E. Merrill Publishing Company. Toronto.
3. Gayakwad, R. A. (2004). Op-amps and linear integrated circuits. 4th Edition. New Delhi: Prentice Hall.
4. P.S. Bimbhra. (2002). Power Electronics. 3rd Edition, India: Khanna Publishers.
5. Lander C.W. (1987). Power Electronics. 2nd Edition. New York: McGraw-Hill Book Company.

6. Graeme J.G. (1973). Application of Operational Amplifiers: Third Generation Techniques., New York: McGraw-Hill. The Burr-Brown Electronics Series.
7. Mohan N., Undeland T. M., Robbins W. P. (1989). Power Electronics: Converters, Applications and Design. New York: John Willey and Sons.