|  |
| --- |
| **ANALOG ELECTRONICS II**  **120(H)** |

***Objectives***

At the end of the course, the student will be able to:

1. Knowledge the classes of the power amplifiers and explain the principle and the applications of these types.

2. Describe the tuned amplifiers.

3. Describe the differential amplifier as an introduction to the operational amplifier.

4. Explain the principle of the operational amplifier.

5. Present some applications of the operational amplifier.

6. Explain the principle of negative and positive feedback.

7. Present some applications of negative and positive feedback.

8. Explain the principle of operation of the IC555 and its applications.

9. Determine the waveforms of the IC555 application circuits.

***Teaching Methodology***

The purpose of Electronics I and Electronics II courses is to cover the basic elements and to provide students with common knowledge in electronics such as: telephony, digital electronics, communications, television and audio-visual equipments.

The methodology is to assure the continuity between the different elements in electronics and deal with the subject as follows:

1. Start with an explanation of the classes of power amplifiers and their analysis and applications.
2. Explain the principle of operation of the tuned amplifier and multistage tuned amplifiers; show their response curves, quality factors and utilizations.
3. Explain the principle of operation of the differential amplifier as an entrance to understand the operational amplifier.
4. Explain the operational amplifier as an electronic device: symbol ,biasing,

characteristics in addition to its applications.

1. Explain the operational amplifier with negative and positive feedback and their applications.
2. Present the internal equivalent circuit of the IC555, and explain its principle of operation.
3. Show and explain the application circuits of the IC555 in addition to their waveforms.

The instructor should assist the students in presenting a real system and guiding them to ask questions in class. He should reinforce the concepts developed in the lectures by showing practical exercises and applications.

***Teaching aids:***

* Overhead projector or power point on white board or active board with accessories.
* A notebook.
* A technical manual.
* A multi-media computer (if possible).
* Technical information documentaries (movies).
* Library access (guided if possible).

***Contents:***

|  |  |
| --- | --- |
|  | **Hours** |
| 1. Power amplifiers | 18 |
| 2.Selective amplifier | 8 |
| 3. Differential amplifier | 10 |
| 4. Applications of the operational amplifier | 24 |
| 5. Negative feedback | 6 |
| 6. Voltage regulation with transistor and operational amplifier | 10 |
| 7. Positive feedback and oscillators with transistor and operational amplifier | 22 |
| 8.Schmitt trigger | 8 |
| 9.The IC555 | 14 |
| **Total** | **120** |

**First part: *Power amplifiers* *(26h)***

**Skills:**

At the end of this part, the student will be able to:

1. Determine the role of a power amplifier.
2. Identify the various types of power amplifiers.

3. Determine the applications of power amplifiers.

**Evaluation**:

The student will be evaluated according to his aptitude to:

1. State the different types of transistor power amplifiers.
2. Determine the electrical circuit, the principle of operation (using the characteristic curves), the efficiency, the output power, the input impedance, the output impedance and the applications for each type of power amplifiers.
3. Define the principle and determine the main characteristics of the tuned amplifier circuit, the principle of operation, response curve and the quality factor.

4. Present the multistage of the tuned amplifier circuit and explain its principle of operation.

***Chapter 1*: *Power amplifiers* *(18h)***

1. Class A power amplifier:

. Circuit.

. Basic operation.

. DC load line.

. AC load line.

. Large signal load line operation.

. Centering the Q point on the DC and load line.

. Nonlinear distortion.

. Voltage gain.

. Power gain.

. Output power for different A point positions.

. Operating point.

. Input and output impedances.

. Efficiency.

. Utilization.

. Exercises.

2. Class B and class AB push-pull power amplifier:

. Circuit.

. Basic operation.

. Q point.

. Crossover distortion.

. Nonlinear distortion.

. The current mirror.

. Input and output impedances.

. Voltage gain.

. Power gain.

. Output power.

. Efficiency.

. Power dissipation.

. Utilization.

. Exercises.

3. Class C power amplifier:

. Circuit (load is resistance or LC).

. Basic operation.

. DC load line.

. AC load line.

. Centering the Q point on the AC and AC load line.

. Voltage gain.

. Power gain.

. Output power.

. Input and output impedances.

. Efficiency.

. Power dissipation.

. Utilization.

. Exercices.

***Chapter 2: Selective amplifier (8h)***

1. Tuned amplifier:

. Circuit.

. Principle of operation.

. Role of each element.

. Response curve of LC and quality factor.

. Utilization.

2. Multistage tuned amplifier:

. Circuit.

. Principle of operation

. Role of each element.

. Response curve of LC and quality factor.

. Utilization.

**Second part: *Operational amplifier (34)***

**Skills:**

At the end of this part, the student will be able to:

1. Determine the role of the differential amplifier.

2. Show the different types of differential amplifiers.

3. Determine the common mode input and common mode rejection ratio CMRR

of the types of differential amplifiers.

4. Determine the characteristics of an operational amplifier and determine its field of application.

5. Deep knowlegment in the most applications and utilizations of the operational amplifier.

**Evaluation**

The student will be evaluated according to his aptitude to:

1. Define the role of the differential amplifier; show the different types of the differential amplifiers and their fundamental properties.

2. Explain the principle of operation of the different types of differential amplifiers and determine their common mode input and common mode rejection ratio CMRR.

1. Determine the characteristics of the ideal and real operational amplifier.
2. Explain the principle of operation of the following operational amplifier application circuits:

a) Voltage follower, b) Non-inverting amplifier, c) Inverting amplifier,

d) Comparator, e) Adder amplifier, f) Difference amplifier, g) Integrator, h) Differentiator, i) Active half-wave rectifier, j) Active positive limiter, k) active positive and negative clamper, l) active peak detector , m) Active filters from first order.

5. Show the waveforms of each circuit.

6. Compare between the types of first order active filters.

***Chapter 3: Differential amplifier (10 h)***

1. Differential amplifier:

. Circuit.

. Principle of operation.

. Role of each element.

. Non-inverting input and inverting input.

. Differential input.

. Common mode input.

. Common mode rejection ratio CMRR.

2. Differential amplifier with constant current source:

. Circuit.

. Principle of operation.

. Role of each element.

. Common mode rejection ratio CMRR.

3. Operational amplifier:

.Definition.

. Characteristics of operational amplifier.

. Op-Amp equivalent circuit.

. Op-Amp frequency response.

. Biasing of operational amplifier.

. Slew rate.

. Offset errors.

***Chapter 4: Applications of the operational amplifiers*** *(****24h)***

1. Operational amplifier applications:

Voltage follower, non-inverting amplifier, inverting amplifier, comparator, adder amplifier, difference amplifier, integrator, differentiator, active half-wave rectifier, active positive limiter, active clamper, active peak detector.

For each one:

. Circuit.

. Principle of operation.

. Role of each element.

. Relation between input and output voltages.

. Waveforms.

2. Active filters: (Simple mathematical analysis):

. Low pass filter (first order).

. High pass filter (first order).

. Band pass filter (first order).

For each one:

. Role.

. Circuit.

. Principle of operation.

. Characteristic curves A = f (f).

. Cutoff frequencies.

**Third part: *Negative feedback (6h)***

**Skills:**

At the end of this part, the student will be able to:

1. Determine the role of the negative feedback.

2. Identify the various connection types of the negative feedback.

3. Explain the principle of the various connection types of the negative feedback.

4. Determine and explain the principle of operation of the negative feedback application circuits for: a) two stages amplifier, b) push pull audio amplifier.

**Evaluation**:

The student will be evaluated according to his aptitude to:

1. State the different types of the various connection types of the negative feedback.

2. Determine the block diagram for each type of the negative feedback connections and explain its principle of operation.

3. Present the principle of operation and determine the main characteristics of the two stages amplifier circuit using negative feedback.

4. Present the principle of operation and determine the main characteristics of the push-pull amplifier circuit using negative feedback.

***Chapter 5: Negative feedback (6h)***

1. Negative feedback.

. Definition.

. Connection types of negative feedback and principle of each type.

. Advantages.

. Utilizations.

2. Negative feedback applications:

. The amplifier using two stage negative feedbacks.

. The push pull audio amplifier with negative feedbacks.

For each one:

. Circuit.

. Principle of operation.

. Role of each element.

**Fourth part : Voltage *regulator (10h)***

**Skills:**

At the end of this part, the student will be able to:

1. Specify the role of the voltage regulation.
2. Determine and analyze the electronic circuit of a voltage regulation with transistor, operational amplifier and integrated circuit regulator.

**Evaluation**:

The student will be evaluated according to his aptitude to:

1. Represent the DC power supply by its functional block diagram, explain briefly the principle of operation of each block, state their properties, deduce the necessity of production of the DC current.
2. Study the principle of operation of a regulation circuits using transistor, operational amplifier and Integrated circuit.

**Chapter 6*: Voltage regulation with transistor and operational amplifier (10h)***

1. Objective of direct current voltage source:

. Functional block diagram.

. The transformer.

. The rectifier.

2. The filter:

. Filter using capacitor.

. Ripple factor.

. Approximated calculation of the filter capacitance.

. Filter using inductance.

3. Zener diode regulator: circuit, principle of operation, role of each element.

4. Zener diode and emitter follower: circuit, principle of operation, role of each element.

5- Negative feedback voltage regulator: circuit, principle of operation, role of each element.

6. Voltage regulator with current limiting: circuit, principle of operation, role of each element.

7. Voltage regulator using operational amplifier: circuit, principle of operation, role of each element.

8. Integrated circuit regulator (series 78aa, 79aa, LM317 or others): principle of operation, role of each element.

**Fifth part : *Positive feedback (30h)***

**Skills:**

At the end of this part, the student will be able to:

1. Determine the role of the positive feedback.

2. Explain the aim of the positive feedback.

3. Determine the conditions of oscillation.

4. Explain the principle of operation of positive feedback application circuits,

by transistor and operational amplifier for many types of sine wave oscillators.

1. Determine the voltage gain Av, the feedback coefficient B, and the resonant frequency of each oscillator.
2. Identify the role of Schmitt trigger and explain its principle of operation.
3. Explain the principle of operation of square and triangular oscillators.
4. Show the waveforms and determine the period and the frequency of the signals that are produced by the square and triangular oscillators.

**Evaluation**:

The student will be evaluated according to his aptitude to:

1. State the principle of positive feedback.

2. Determine the block diagram of positive feedback and its principle of operation.

3. Present the principle of oscillation and determine the conditions of oscillation.

4. Describe the electronic circuits of the sine wave oscillators and determine their characteristics.

5. Assign the voltage gain Av, the feedback coefficient B, and the resonant frequency of each sine wave oscillator.

6. Describe and understand the electronic circuits of the square and triangular oscillators and determine their characteristics.

7. Assign the period and the frequency of the signals of the square and triangular oscillators.

**Chapter 7*: Positive feedback and oscillators with transistor and***

***operational amplifier (22h)***

1. Positive feedback:

. Definition.

. Principle of operation (block diagram).

. Advantages.

. Utilizations.

. Oscillator principle.

. Conditions of oscillation.

2. Sinusoidal oscillators by using transistor and operational amplifier:

. RC or CR phase shift oscillator.

. Wien bridge oscillator.

. T win T oscillator.

. Colpitts oscillator.

. Hartley oscillator.

. Clapp oscillator.

. Crystal oscillator.

For each one:

Circuit, principle of operation, role of each element, resonant frequency (simple analysis).

**Chapter 8*: Schmitt trigger (8h)***

1. Schmitt trigger produces a square wave output:

. Circuit.

. Principle of operation.

. Waveforms.

2-Op-amp Schmitt trigger:

. Circuit.

. Principle of operation.

. Waveforms.

. The formats UTP and LTP.

3. Op-amp relaxation oscillator:

. Circuit.

. Principle of operation.

. Waveforms.

4. Triangular generator using relaxation oscillator with integrator:

. Circuit.

. Principle of operation.

. Waveforms.

**Sixth part : *IC555 (14h)***

**Skills:**

At the end of this part, the student will be able to:

1. Knowledge the characteristics and the symbol of the IC555.

2. Knowledge the applications which are used by the IC 555.

3. Explain the principle of operation of the following application circuits:

a) Monostable multivibrator, b) bistable multivibrator, c) astable multivibrator,

d) Voltage controlled oscillator, e) Sawtooth generator.

4. Show the waveforms and determine the period and the frequency of the signals that are produced by IC555 application circuits.

**Evaluation**:

The student will be evaluated according to his aptitude to:

2. Know the principle of operation of the IC555.

3. Present the characteristics and the symbol of the IC555.

4. Describe and analyse the electronic circuits of the IC555 applications and determine their characteristics.

5. Assign the period and the frequency of the signals that are produced by the

IC555 application circuits.

**Chapter 9*:*  The IC 555 (14 h)**

1. Block diagram of IC555:

. Internal circuit.

. Role of each element of the internal circuit of the IC 555.

. Principle of operation of the IC 555.

. Characteristics of the IC 555.

. Symbol of the IC555.

2. Monostable Multivibrator by IC555:

. Circuit.

. principle of operation.

. Role of each element.

. Waveforms.

3. Bistable Multivibrator by IC555:

.Circuit.

.Principle of operation.

.Role of each element.

.Waveforms.

4. Astable Multivibrator by IC555:

. Circuit.

. Principle of operation.

. Role of each element.

. Waveforms.

5.Voltage controlled oscillator by IC555:

. Circuit.

. Principle of operation.

. Role of each element.

. Waveforms.

6. Sawtooth generator by IC 555 and transistor:

. Circuit.

. Principle of operation.

. Role of each element.

. Waveforms.

7. Sawtooth generator using Schmitt trigger, IC 555 and transistor:

. Circuit.

. Principle of operation.

. Role of each element.

. Waveforms.