**TS1 Electronics PW-Analog electronics**

**PW-Analog electronics**

**(120 H**)

***General Objectives:***

**At the end of these practical sessions, the student will be able to:**

**- Use the electronic measuring equipment**

**- Test and use various passive elements**

**-Realize the different diode circuits and measure the current and voltage signals of**

**these circuits in addition to obtain the characteristics curve of diode**

**- Realize the various circuits by using bipolar and JFET, MOSFET transistor and**

**measure the input and output signals furthermore the characteristics curve of the**

**bipolar transistor Ic=f(VCE) where IB is constant**

**-Realize the various circuits by using diode and bipolar transistor act like a switch**

**- Design various printed electronic circuits manually and by using scientific**

**programs**

**- Realize the different types of differential amplifiers as introduction to operational**

**amplifier**

**- Test and determine the characteristics of differentional amplifier circuits**

**- Set up and test the basic circuits of an operational amplifier**

**-Realize and test the non sinusoidal oscillators**

**- Realize and test the sinusoidal oscillators**

**- Realize and test the DC voltage regulation circuits by using transistor and**

**operational amplifier**

**-Make the measurements of the internal capacities for the transistor at high**

**frequencies**

**- Realize the tuned amplifier circuit for one stage and double stages and plot the**

**response curve of tuned circuit, and determine the bandwidth**

***N.B:* Realize all the below circuits by assembly or by software or by didactic benches.**

***Contents:***

***Chapter 1: Use of measuring instruments*** **(4 H)**

**Prerequisite:**

-Basic ideas about AC and DC voltage and current parameters

-Basic idea about triangular and rectangular waves

**Practical works:**

-Measurement of the DC and AC voltages using digital voltmeter

-Measurement the DC and AC currents using digital ammeter

-Comparison between the measuring values using analog and digital meters

-Regulating the oscilloscope

-Measurement of peak voltages, periods and frequencies of sinusoidal signals, saw tooth signals, rectangular and pulse signals

-Comparison between two signals using the dual trace oscilloscope

-Measurement of the phase angles

***Chapter 2: Electric components*** **(2H)**

**Prerequisite:**

-Read the specification

-Choose electric components according to standard and normalized values:

-Resistances

- Inductance

-Capacitances

-Color codes of components

-Precision and tolerance

**Practical works:**

-Measurement of the resistances using the ohmmeter

-Measurement of the inductances using a Henrimeter or multimeter

-Measurement of capacitances using a digital millimeter

-Reading of the color codes for resistances and capacitances

***Chapter 3: Diode applications***  **(10H)**

**Prerequisite:**

-Principle of the operation of a diode

-Different types of diodes:

-PN junction

- Zener

-Diode equation

-Diode characteristics: forward and reverse biasing

-Breakdown voltage

-The threshold voltage of a zener diode

-Temperature effect

-Study the different diode circuits:

- Rectifier: full wave and half wave

-Voltage doubler and voltage Tripler

-Limiter

- Voltage regulator

**Practical works:**

-Test a diode by an ohmmeter to measure its internal resistance

-Biasing of the PN junction diode

-Realize the forward and reverse characteristics of the diode

-Realize the following circuits:

1- Half wave rectifier

2-Full wave center tapped transformer rectifier

3-Full wave bridge rectifier

4- Voltage doubler

5-Voltage Tripler

6-Limiter

7-Clamper

8-Stabilized rectifier by using zener diode and RC or LC filter

-Observe by oscilloscope the input and output voltages of each circuit

-Measure the input and output voltages and compare them with the theoretical values

-Measure the current in the circuits by using ampermeter

***Chapter 4: Bipolar transistor*** **(14 H)**

**Prerequisite:**

-Symbol of transistor NPN and PNP

-Transistor biasing

-Definition of the following parameters:

α, β, IB, IC, IE and voltage gain Av

-Characteristics curve and operating point of the transistor

-The principle of operation of the following circuits:

- Common emitter amplifier

- Common collector amplifier

- Common base amplifier

-The coupling types

-Darlington pair

-Multistage amplifier

**Practical works:**

-Test the transistor by using ohmmeter or transistor tester

-Realize the characteristic curve of the transistor IC=f (VCE) where IB is constant. Repeat this experiment by taking another value of IB

-Realize the following circuits:

1- Common emitter amplifier

2- Common collector amplifier

3- Common base amplifier

4- Two stages amplifier by using RC coupling

5 Two stages amplifier by using LC coupling

6- Two stages amplifier by using transformer coupling

7- An amplifier using Darlington pair

-Measure the DC currents of each circuit: IB, IC, IE

-Measure the DC voltages of each circuit: VBE, VCE

-Determine the DC operating point of each circuit

-Measure the AC currents of each circuit: ie, ic, ib

-Measure the AC voltages: vce, vbe of each circuit

-Determine the AC operating point

-Draw the DC and AC load line

-Measure the input impedance

-Measure the output impedance

-Measure the current gain

-Measure the voltage gain

-Measure the phase angle between the input and the output voltages

-Interpretations and comparison between practical and theoretical results

***Chapter 5: Field effect and MOSFET transistors*** **(12H)**

**Prerequisite:**

-Construction and symbol of JFET and MOSFET

-Principle of operation

-Biasing conditions

-Characteristics curves

-Difference between bipolar transistor and field effect transistor

**Practical works:**

-Test the field effect transistor

-Realize the following circuits by using JFET and MOSFET:

1- Common source amplifier

2- Common drain amplifier

3- Common gate amplifier

4-Two stages amplifier using FET and bipolar transistor

5- Two stages amplifier using FET only

-Measure the DC currents and DC voltages of each circuit

-Measure the AC currents and AC voltages of each circuit

-Determine the DC operating point of each circuit

-Determine the AC operating point of each circuit

-Measure the input and output resistance

-Measure the voltage gain

-Measure the phase between input and output waveforms

-Interpretations and comparison between obtained and theoretical results

-Choice of the transistor by using data sheets

***Chapter 6: Power amplifiers***  **(8 H)**

**Prerequisite:**

-The basic principles of class A, B, AB and C power amplifiers

-The principle of operation of each class

-Operating point of each class

-DC and AC load line of each class

-Crossover distortion in class B and class AB push pull amplifier

-Non linear distortion in class B and class AB push pull amplifier

-Voltage gain

-Current gain

-Power gain

-Output power

-Power dissipation

-Input impedance

-Output impedance

-Efficiency

-Mirror current in class B push pull amplifier

**Practical works:**

-Realize the push-pull amplifier with complementary transistors

-Realize the push-pull class AB power amplifier with complementary transistors

-Realize the push-pull amplifier with transformer

-Realize the push-pull amplifier with Darlington pair

-Realize the class C power amplifier circuit with the resistance on the collector

-Measure the DC currents and voltages of each circuit

-Measure by oscilloscope the input and the output waveforms of each circuit

-Observe by oscilloscope the crossover distortion in class B and AB push pull

amplifier

***Chapter 7: The diode and bipolar transistor act like switch*** **(4H)**

**Prerequisite:**

-Transistor cut-off and saturation

-Limits of operation

-Diode in commutation regime

-Basic logic functions

**Practical works:**

-Realize the following logic functions using diodes and transistors: inverters, AND, OR, NAND and NOR

-Truth table and measure of the input and output voltages and currents of each circuit

-Realize the following circuits:

1-Schmitt trigger

2- Monostable

3- Bistable

4- Astable

-Measure by oscilloscope the currents and the voltages waveforms due to these circuits

***Chapter 8: Production of printed circuits*** **(8 H)**

**Prerequisite:**

-Symbol and color codes for different types of components

-Technical electrical design: isolation, etching, drilling and soldering

-Implementation of component cabling design

-Scientific programs for routing and cabling

**Practical works:**

-Fabrication procedure of printed circuit (normal and photosensitive)

-Implementation plan

-Plan of cabling:

- Manuals

- Specific electronic and printed circuit programs

-List of interconnections

-Nomenclature

-Cabling and implementation error detection

-Isolation, revelation and etching

-Drilling the board

-Soldering and finishing

-The board should be made

-Realize many given electronic circuits by using printed circuit

***Chapter 9: Differential amplifiers*** **(8 H)**

**Prerequisite:**

-The basic operation of differential amplifier

-DC and AC analysis

-Input and output impedance

-Non- inverting and inverting input

-Common mode input

-Common mode rejection ration CMRR

**Practical works:**

-Realize the differential amplifier circuit by using bipolar and JFET transistor

-Realize the differential amplifier circuit with constant current source

-Realize the differential amplifier circuit with the emitter resistors for balance

1- Measure the DC currents and voltages for these circuits

2-Observe by oscilloscope the input and output signals

3- Measure by oscilloscope the input and output voltages of these circuit

4- Determine the value of CMRR of this circuit

5-Interpret the obtained results

***Chapter 10: Operational amplifiers*** **(20H)**

**Prerequisite:**

-Basic Op-amp characteristics

-Op-amp equivalent circuit

-Op-amp frequency response

-Slew rate and offset errors

-Applications of the operational amplifiers: voltage follower amplifier, non-inverting amplifier, inverting amplifier, comparator, summing amplifier, difference amplifier, integrator, differentiator, half wave rectifier, clipper, full wave rectifier, clamper, passive peak detector, Logarithmic amplifier, Antilogarithmic amplifier, low pass filter, high pass filter and band pass filter (second order).

**Practical works:**

-Realize the following operational amplifier circuits:

1- Voltage follower amplifier

2- Non-inverting amplifier

3- Inverting amplifier

4-Adder amplifier

5- Difference amplifier

6- Integrator

7-Differentiator

8-Comparator

● Half wave rectifier

1- Clipper

2-Full wave rectifier

3-Clamper

● Peak detector

● Logarithmic amplifier

● Antilogarithmic amplifier

1- Low pass filter (second order)

2- High pass filter (second order)

3- Band pass filter (second order)

-Observe by oscilloscope the input and output waveforms of each circuit

-Measure by oscilloscope the input and output waveforms of each circuit

-Measure the voltage gain of each circuit

-Measure the phase angle between input and output waveforms of each circuit

-Obtain the voltage gain versus frequency response

-Interpret the obtained results of each circuit

-Observe by oscilloscope the input and output waveforms of each circuit

-Measure by oscilloscope the input and output waveforms of each circuit

-Plot the frequency response for the filters

-Determine the voltage gain and the bandwidth for the filters

-Interpret the obtained results

***Chapter 11: Oscillators by using Op-amp***  **(20 H)**

**Prerequisite:**

-Non sinusoidal oscillators

-Sinusoidal oscillators with two port positive feedback network:

- Principle of operation

-Analysis and waveforms

**Practical works:**

-Realize the following multivibrator circuits:

1- Schmitt trigger

2- Monostable

3-Bistable

4- Astable

-Realize the non sinusoidal oscillators:

1-Triangular oscillator

2-Relaxation oscillator

3- Voltage controlled oscillator

-Realize the sinusoidal oscillators:

1- RC or CR phase shift oscillator

2-Wien bridge oscillator

3-Colpitts oscillator

4- Hartely oscillator

5- Crystal oscillator

-Observe by oscilloscope the input and output voltages of each circuit

-Measure the output voltage and the period of produced signal

-Measure the phase between two sine wave signals

***Chapter 12: Voltage regulation*** **(10H)**

**Prerequisite:**

-Rectifying and filtering

-Zener diode regulator

-Negative feedback

**Practical works:**

-Realize a voltage regulator using a transistor and a zener diode

-Realize a negative feedback voltage regulator using transistors

-Realize a DC voltage regulator with current limiting using transistors

-Realize a series and parallel regulators using operational amplifiers

-Realize a voltage stabilized circuit using integrated regulators LM340 series

-For the above mentioned circuits:

-Measure the output voltage in terms of the input voltage

- Determine the limits of stabilization

***Chapter 13: Transistor at high frequency***  **(2H)**

**Prerequisite:**

-Junction capacitances

-High frequency equivalent circuit

-Transistometer

**Practical works:**

-Measure the following elements at the high frequency:

1- The internal resistance of the base junction

2- The ratio Cbc / Cbe. Cbc and Cbe represent the internal capacitances of

transistors

3-The cut-off frequency (critical)

***Chapter 14: Tuned amplifiers***  **(2H)**

**Prerequisite:**

-Principle of tuned amplifier

-One stage or multi-stage tuned circuits

-AC equivalent circuit

-Response circuit

-Bandwidth

**Practical works:**

-Realize a tuned common emitter amplifier

-Plot the curve of voltage gain against frequency response

-Repeat the same experiment by using common source field effect transistor amplifier

-Interpret the obtained results