King Saud University
Collage of Applied Medical Sciences
Biomedical Technology Department

BMT485
Level9
Lab1

Some Useful Analog Circuits

Objectives

Upon completion of this lab you'll be able to understand the following points

1. **Power supply component and a simple design of the power supply**
2. **Regulation (Line regulation and Load regulation), regulator and regulators types(Linear , switching)**
3. **Relays (Mechanical, Reed, Solid state)**
4. **Oscillation and oscillators types**
5. **Op-Amp (TL064, TL074, TL084, LM324) and different circuit (summer, Average…), Bipolar transistor (2N3904, 2N3906, BC108)**
6. **Analog MUX/DEMUX (4051, 4052, 4053)**

Introduction

This lab is a revision on some basic and useful analog circuit that will help us with the next labs and the project, many references will be available on these topics that will help and guide you through this lab and the next labs. Deep understanding of this lab objective is a must because it helps you to decide which circuits are needed for your project design and why you need such a design also it serves as a basic knowledge of some important circuits.

Pre-requisite

"Subjects to be understood before launch this lab"

No special pre-requisites are needed however the measuring skills of current, voltage, and resistance using the multi-meter are must

Required equipments

- **Multi-meter**
- **Oscilloscope**
- **Function generator**

Experiment steps

We are going now to discuss some basic and important circuits all what we need to do is to understand the design and function of these circuits and to setup some of these circuits.

Power Supply

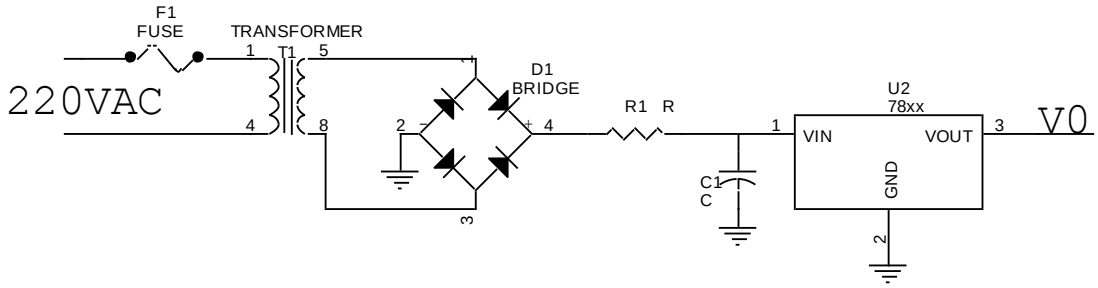


Figure 1

Transformers equation

V1/V2=N1/N2=I2/I1

Types of transformer

- **Step up**
- **Step down**
- **Isolation (impedance matching)**

Regulation and regulators

Line Regulation

Can be defined as the percentage change in the output voltage for a given change in the input *line* voltage

Line Reg = (Δ Vout/Vout) / Δ Vin *100%

Load Regulation

Can be defined as the percentage change in the output voltage for a given change in the load current

Load Reg = (Vnl-Vfl)/Vfl *100%

Types of regulators

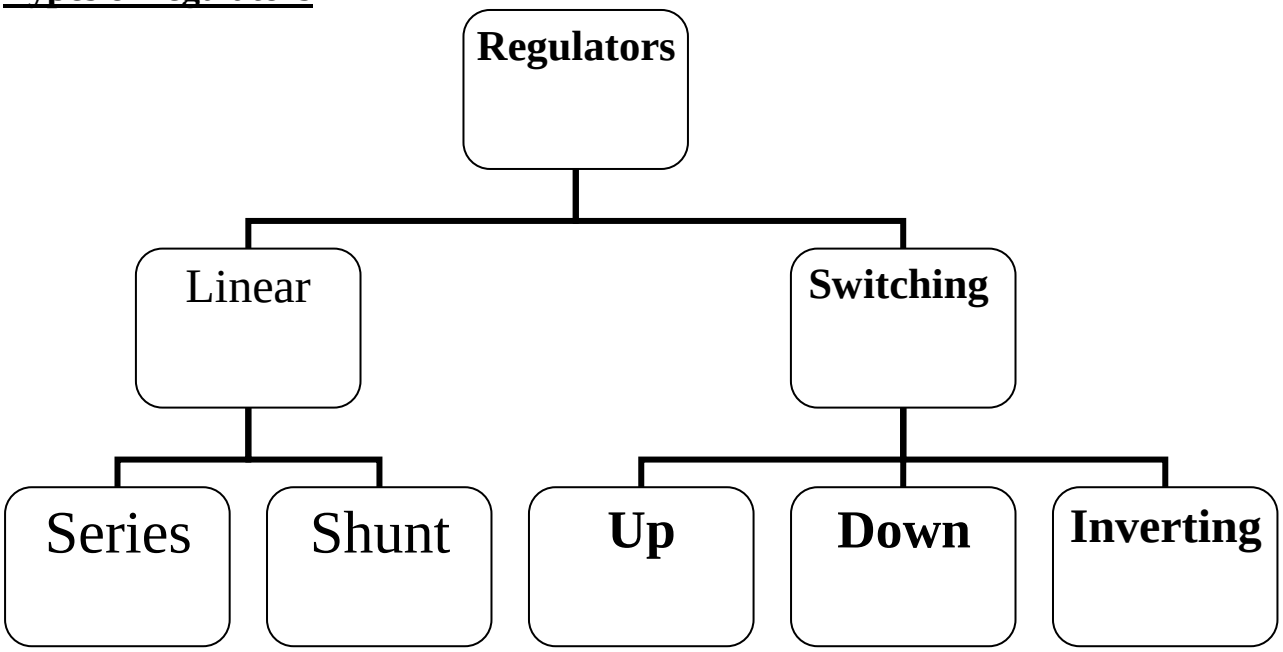


Figure 2

Regulators

A voltage regulator provide a constant dc-output voltage independent of the input voltage output load current and temperature

Regulator 79XX (Negative regulator) **Regulator 78XX (Positive regulator)**

Figure 3

Relays
Types of relays

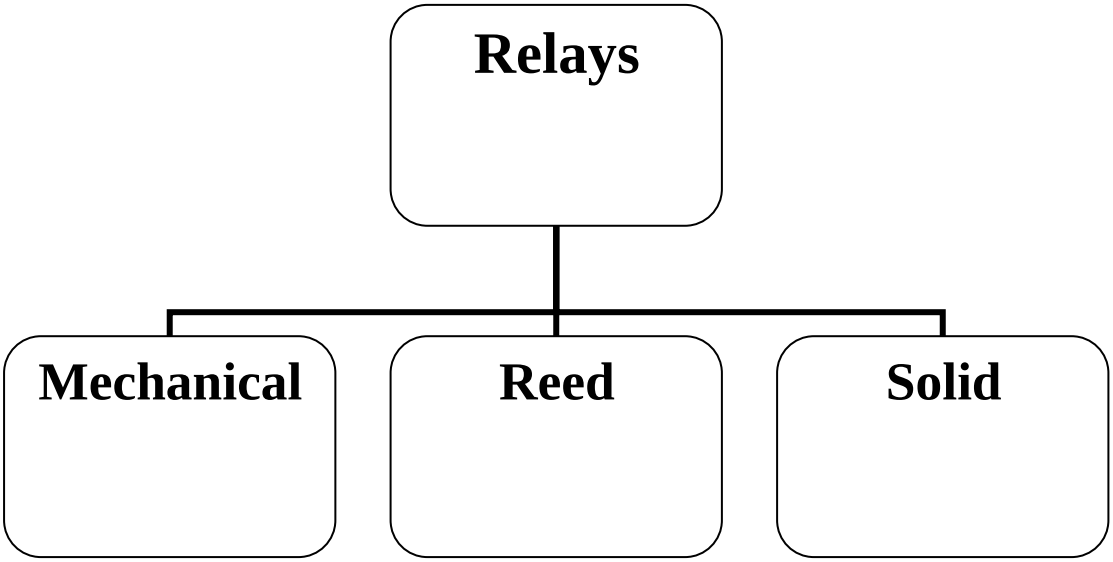


Figure 4

A relay is a device that interfaces the high voltage AC to micro-computer (low power or low voltage devices). The control circuitry for a relay is electrically isolated from the actual switch this is very important to protect the PC from short circuit with the high voltage AC

Mechanical relay

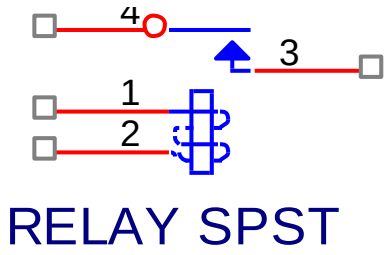


Figure 5

Mechanical relays are called contactors they are suffered from

1. **Mechanical contact degraded so increasing the contact resistance**
2. **EMI interference because switching could happen at any part of the AC cycle.**
3. **Arcing that result from switching on the relay coil**

Reed relay

Almost as the mechanical relays except it could handle less current in the coil

Solid state relay

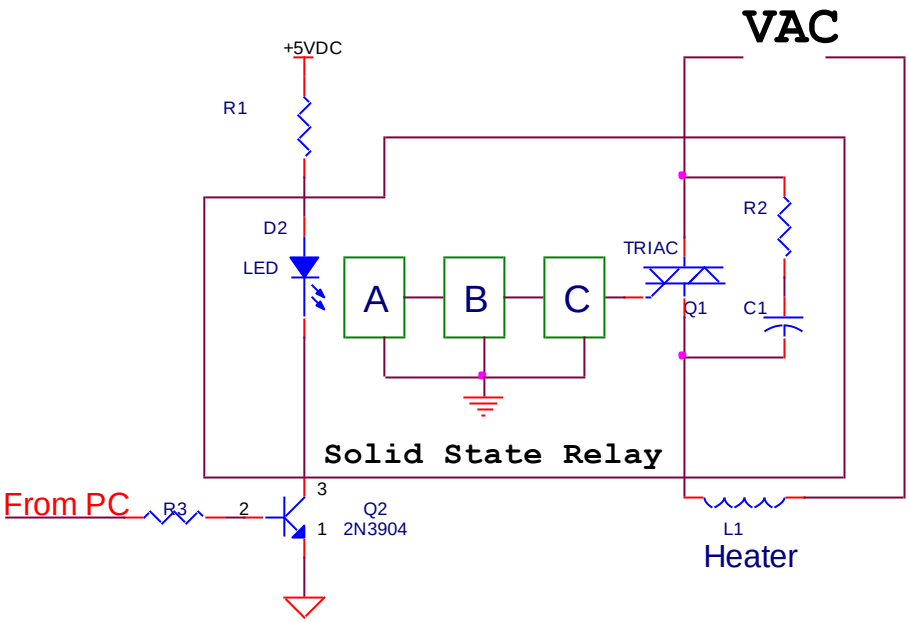


Figure 6

A=Phototransistor
B=Zero-crossing Detector
C=Trigger CKT
D="Consist of R2 and C1" Snubber circuit

When the switch is on "Q2" light from the LED D2 is forced on "A" then through "B" and the trigger circuit firing the TRIAC at a point near zero to conduct 110/220VAC to a coil or heater.

There are several thousand volt of isolation between the input circuitry and the output circuitry.

The relay is turned off when the current of the TRIAC is fall below certain
current (I hold) and if we require it on again so fast it won't conduct until the next cycle of the AC current at a point so near to zero so minimizing EMI interference.

Solid state relay problems

1. **So expensive**
2. **When driving a large inductive load like motors at the turn off the back EMF is so large across the TRIAC and may result in turn it on at a time we don't want it to. So using the snubber circuit "D" to reduce this back EMF**

<u>Oscillation and oscillators types</u>

- **Oscillators are circuits that generate an output signal with out an input signal**
- **Different types of oscillators produce various types of out puts including sine, square, and triangular waves**
- **Oscillation operation is based on the principle of the positive feed back. When apportion of the output signal is feedback to the input in away that cause it to reinforce and thus sustain a continuous output signal**

<u>Condition for oscillation</u>

1. **Phase shift around the feedback loop must be zero**
2. **the voltage gain around the closed feedback loop must be unity**

RC-circuit that produce sine wave

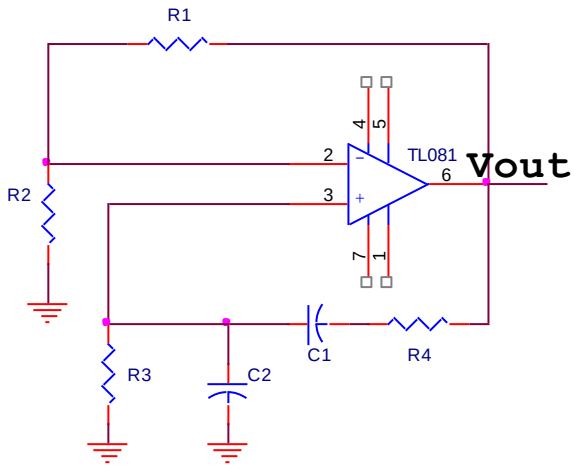


Figure 7

Vout = (1+R1/R2) Vin
If R4=R3=R and C1=C2=C
Fr=1/2πR3C1=1/2πRC

The 555 timer as an oscillator
A stable

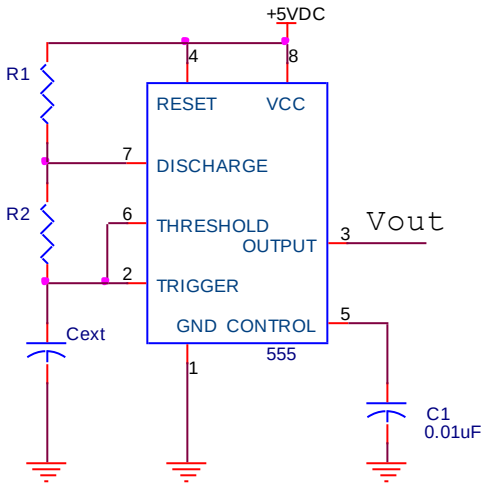


Figure 8

Fr=1.44/(R1+2R2)Cext
D.C=(R1+R2)/(R1+2R2)

In order to achieve duty cycle of less than 50% use the following connection

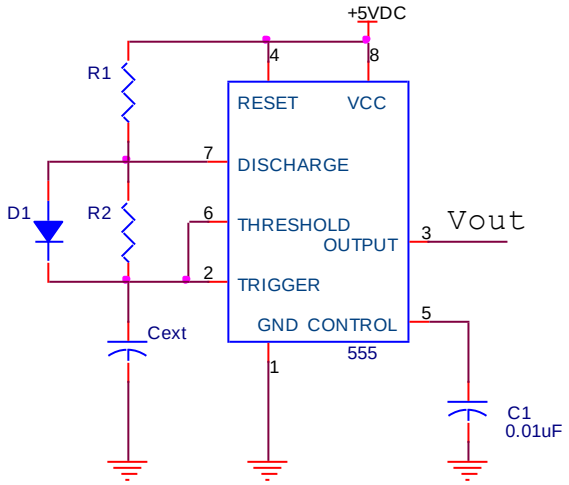


Figure 9

D.C=R1/(R1+R2)

Voltage Controlled Oscillator "VCO"

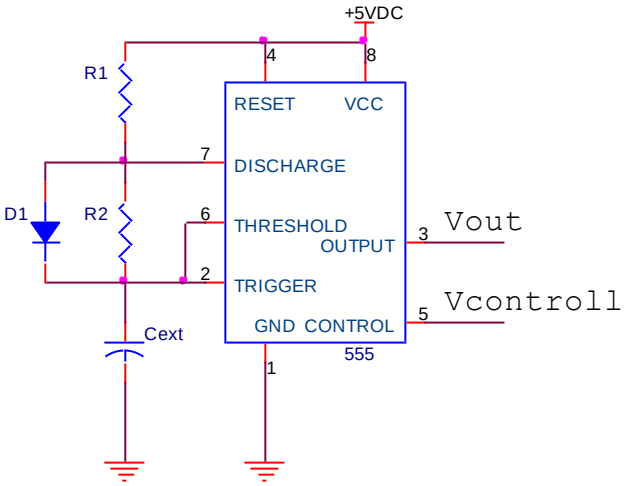


Figure 10

When the control voltage is varied the output frequency also varied. An increase in Vcontroll increasing the charging and discharging time of the external cap Cext causes the frequency to decrease. A decrease in Vcontroll decreases the charging and discharging time of the external cap Cext causes the frequency to increase

Op-Amp Bipolar transistor

(TL064, TL074, TL084, LM324) and different circuit (summer, Average …), Bipolar transistor (2N3904, 2N3906, BC108)

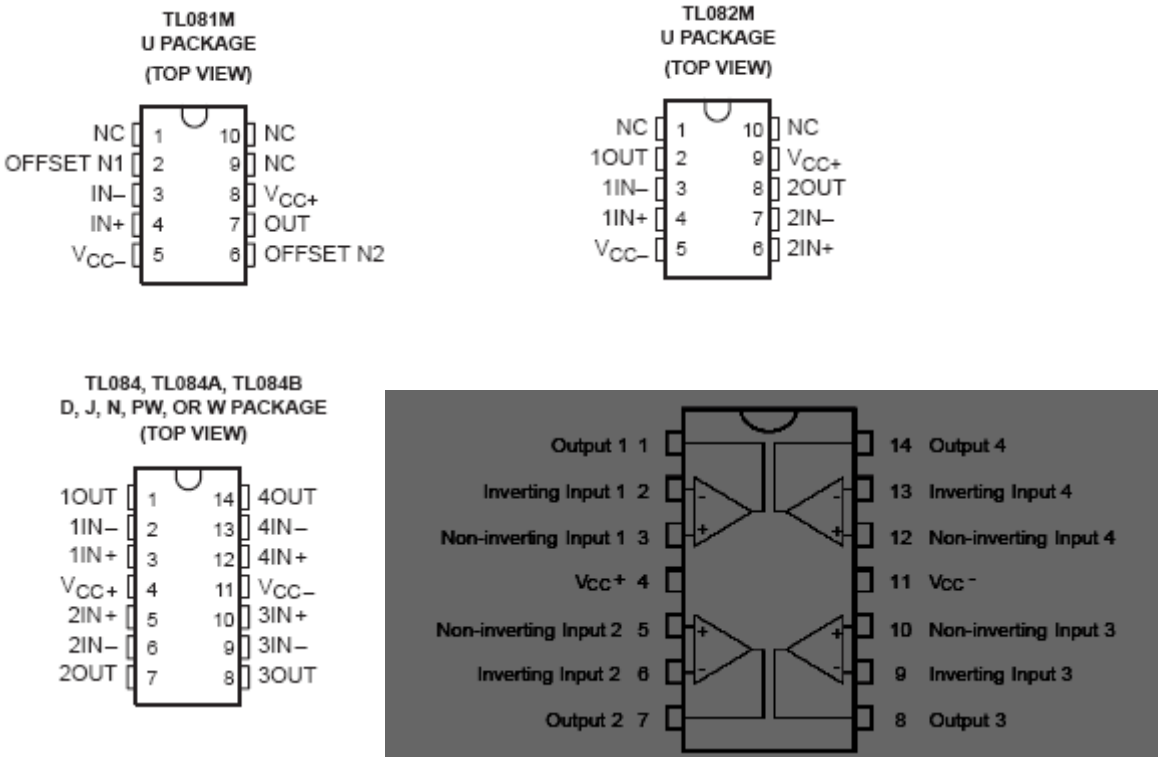


Figure 11

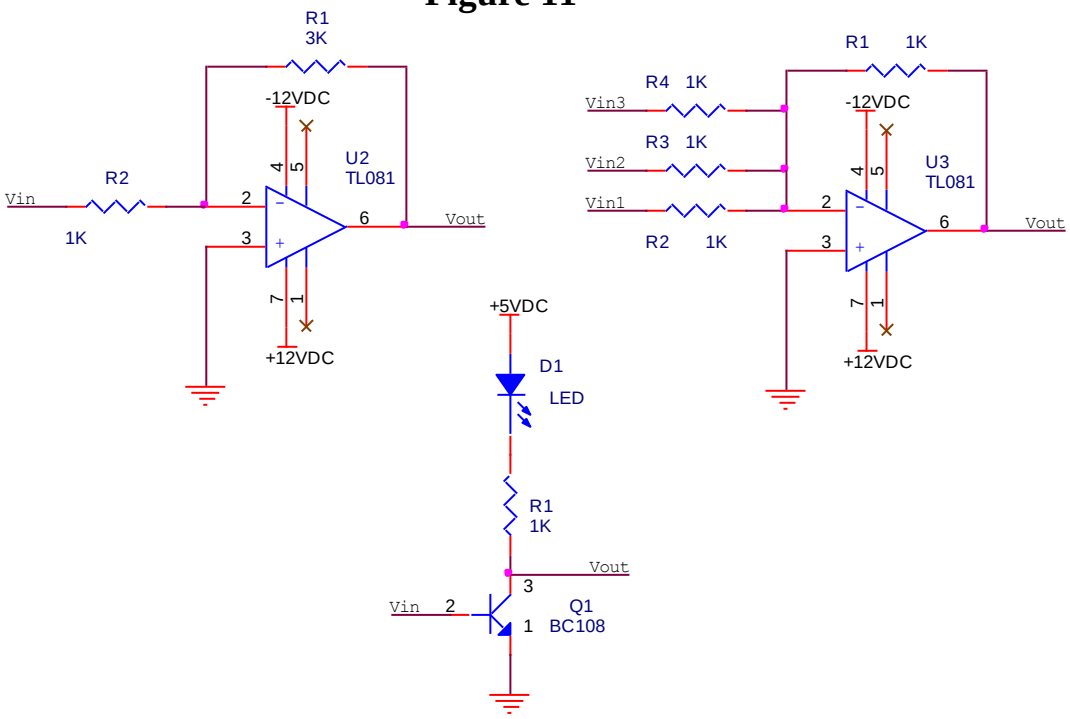
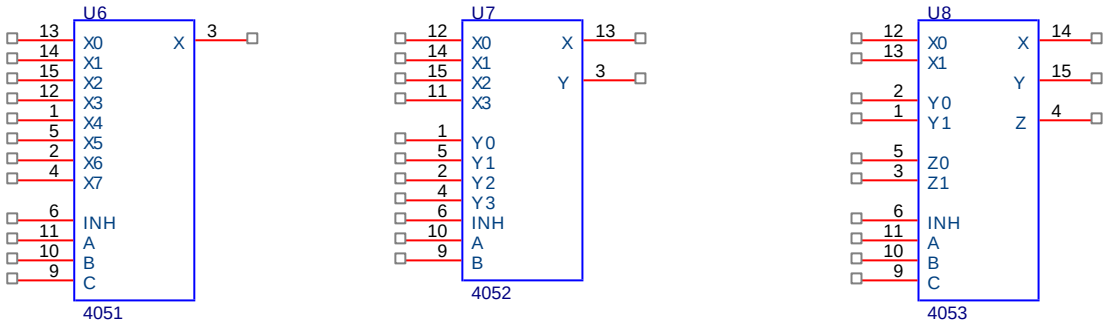


Figure 12

Analog MUX/DEMUX (4051, 4052, 4053)

- **4051 is a Single8-ChannelAnalogMultiplexer/Demultiplexer**
- **4052 is a Dual4-ChannelAnalogMultiplexer/Demultiplexer**
- **4053 is a Triple2-ChannelAnalogMultiplexer/Demultiplexer**



Truth Table

INPUT STATES				"ON" CHANNELS		
INHIBIT	C	B	A	CD4051B	CD4052B	CD4053B
0	0	0	0	0	0X, 0Y	cx, bx, ax
0	0	0	1	1	1X, 1Y	cx, bx, ay
0	0	1	0	2	2X, 2Y	cx, by, ax
0	0	1	1	3	3X, 3Y	cx, by, ay
0	1	0	0	4		cy, bx, ax
0	1	0	1	5		cy, bx, ay
0	1	1	0	6		cy, by, ax
0	1	1	1	7		cy, by, ay
1	*	*	*	NONE	NONE	NONE

*Don't Care condition.

Figure 13

Experiment results and further discussion

As we can noticed from the above discussion we have some basic circuits that we can use it as primitives in functional block diagram design. The main goal of this lab is to understand their function how to design it and to use it in different design situations

Take-home assignment

1. **Use an electronic simulation program such as EWB or OrCAD and simulate the result of Fig7 and record the components values and the output simulated results**
2. **What are the difference between the bipolar transistor and JFET? State which one has a faster switching time?**
3. **If you design an ECG board how would you design the Lead selector circuit? Draw a schematic of your design?**
4. **What is the relationship between the transformer size and the applied frequency? Explain?**