SSBT’s COLLEGE OF ENGINEERING & TECHNOLOGY,
BAMBHORI, JALGAON

DEPARTMENT OF ELECTRICAL ENGINEERING

LABORATORY MANUAL
Analog and Digital Electronics
S.E. ELECTRICAL ENGINEERING

TERM - II
Mission of the Institute

To provide conductive environment for preparing competent, value added and patriotic engineers of integrity of par excellence to meet global standards for societal development.

Vision of the Institute

Today we carry the flame of quality education, knowledge and progressive technology for global societal development; tomorrow the flame will glow even brighter.

Mission of the Program

To provide student-centered conducive environment for preparing knowledgeable, competent and value added electrical engineers.

Vision of the Program

To emerge as leading Electrical Engineering department for inclusive development of students.

Objectives of the Institute:

- To impart innovative teaching and learning
- To provide quality education with futuristic trends in engineering and technology
- To develop the institute as a research center for academic excellence
- To ensure continual improvement in quality management system
- To inculcate social values, patriotism and professional ethics among the students
### PROGRAM OUTCOMES (POs)

<table>
<thead>
<tr>
<th></th>
<th>Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
</tr>
<tr>
<td>3</td>
<td>Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
</tr>
<tr>
<td>4</td>
<td>Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
</tr>
<tr>
<td>5</td>
<td>Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.</td>
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<td>6</td>
<td>The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</td>
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<tr>
<td>7</td>
<td>Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.</td>
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<tr>
<td>8</td>
<td>Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.</td>
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<tr>
<td>9</td>
<td>Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.</td>
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<tr>
<td>10</td>
<td>Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.</td>
</tr>
<tr>
<td>11</td>
<td>Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.</td>
</tr>
<tr>
<td>12</td>
<td>Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.</td>
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</tbody>
</table>

### PROGRAM SPECIFIC OUTCOMES (PSOs)

<table>
<thead>
<tr>
<th></th>
<th>Apply principles of engineering, electronics and computer science; basic science, mathematics (including differential equations, discrete mathematics and linear algebra) and laboratory skills for building, testing, operation and maintenance of electrical systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Model, analyze, design, and realize physical systems, components or processes related to electrical engineering systems.</td>
</tr>
<tr>
<td>3</td>
<td>Be prepared to work professionally in power systems engineering, control systems engineering and software industries.</td>
</tr>
</tbody>
</table>
Course Outcomes:

Upon successful completion of this Course the student will be able to:

1. Apply basic knowledge of science and engineering to understand electronic devices and circuits such as rectifier, amplifiers etc.
2. Analyze the circuit for determination of circuit parameters and response of op-amp IC741 and its applications.
3. Describe the use of different integrated circuits timers, PLL and voltage regulators.
4. Illustrate the basic logic gates and various reduction techniques of digital logic circuit in detail and gain the basic concept of combinational circuits.
5. Able to design sequential circuits using excitation and state table.
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>TITLE</th>
<th>DATE</th>
<th>Page Nos.</th>
<th>Grade</th>
<th>Signature</th>
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<tbody>
<tr>
<td>1.</td>
<td>Observe the input and output voltages of full wave bridge rectifier circuit with and without filter.</td>
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<tr>
<td>2.</td>
<td>Study of Op-Amp As Square Wave Generator Using IC 741</td>
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<tr>
<td>3</td>
<td>Study of Schmitt Trigger Using Op-Amp IC 741</td>
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<tr>
<td>4</td>
<td>Study of Astable, Monostable Multivibrator Using IC 555</td>
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<tr>
<td>5</td>
<td>Study of IC 723 As Low Voltage Regulator</td>
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<tr>
<td>6</td>
<td>Study of IC 723 As High Voltage Regulator</td>
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<tr>
<td>7</td>
<td>Study of Positive Voltage Regulator Using IC 78××</td>
<td></td>
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<td>8</td>
<td>Study of Negative Voltage Regulator Using IC 79××</td>
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<tr>
<td>9</td>
<td>Study of J-K Flip-Flop Using IC 7476</td>
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<tr>
<td>10</td>
<td>Verification of Binary Counter Using IC-7493.</td>
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</tbody>
</table>
Aim: Observe the input and output voltages of full wave bridge rectifier circuit with and without filter.

Apparatus: Full wave bridge rectifier with capacitor filter trainer kit, C.R.O., voltmeter, multimeter, rheostat, C.R.O. probes, connecting wires, etc.

Theory:

A circuit frequently used for electronic d.c. power supplies is a full wave bridge rectifier. In full wave bridge rectifier four diodes are used as shown in fig. During the positive input half cycle, terminal M of the secondary of the transformer is positive while the terminal N is negative. In this situation diodes D_1 and D_3 are forward biased (ON position) i.e., they conduct whereas diodes D_2 and D_4 are reversed biased (OFF position) i.e. they do not conduct. So a current flows along MABCEFN as shown in fig. There will be a voltage drop across R_L. During the negative input half cycle, terminal N of the secondary of transformer becomes positive while the terminal M becomes negative. Under this situation diodes D_2 and D_4 are forward biased (ON position) i.e., they conduct whereas diodes D_1 and D_3 reversed biased (OFF position) i.e., they do not conduct. Now a current flows along NFBCEAM as shown in fig. The current produces a voltage drop across R_L .It is obvious that the current through load resistance R_L is in the same direction during both half cycle of the input a.c. supply.

The advantages of bridge rectifier are:

1. No centre-tap is required on transformer.
2. It is suitable for high voltage applications.
3. Since two diodes are present in series in each conduction path, the peak inverse voltage is equally shared by the two diodes. thus it has less PIV rating per diode.
4. The current in both (primary and secondary) of the supply transformer flows
for the entire a.c. cycle and hence for a given power output, power transformer of small size may be used in comparison with that in full wave rectifier.

Procedure:

1. Make the connections as shown in circuit diagram.
2. Apply supply voltage to the kit.
3. For load regulation keep a.c. supply 230V constant, vary the load resistance & take reading from no load to full load value, & note down voltage & current respectively.
4. Calculate load regulation, also calculate ripple factor theoretically & practically

RESULT:

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CONCLUSION:

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Oral Based Questions

1. What do you mean by bridge rectifier?

2. What is ripple factor?

3. What is the efficiency of bridge rectifier?

4. How many diodes are used in circuit?

5. What are the advantages of this circuit?

Sign
AIM:- Op-amp as square wave generator using IC 741.

APPARATUS:- Dual power supply, Bread board, CRO, CRO probes, connecting wires

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Component</th>
<th>Specification</th>
<th>Quantity</th>
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<tr>
<td>01</td>
<td>Resistor</td>
<td>1 kΩ</td>
<td>01</td>
</tr>
<tr>
<td>02</td>
<td>Resistor</td>
<td>10 kΩ</td>
<td>05</td>
</tr>
<tr>
<td>03</td>
<td>Resistor</td>
<td>100 kΩ</td>
<td>01</td>
</tr>
<tr>
<td>04</td>
<td>Capacitor</td>
<td>47 Nf</td>
<td>01</td>
</tr>
<tr>
<td>05</td>
<td>Capacitor</td>
<td>0.1μF</td>
<td>01</td>
</tr>
<tr>
<td>06</td>
<td>IC-741</td>
<td>------</td>
<td>01</td>
</tr>
</tbody>
</table>

THEORY:-

Square wave output can be obtained when op-amp is forced to sorting respectively. The output of op-amp in circuit will be in positive or negative saturation depending upon whether the differential voltage is negative or positive.

Assume that the voltage across capacitor ‘C’ is zero volts at the instant the voltage +Vcc & - VEE are applied when the voltage V₁ is positive. Since initially the capacitor acts as a short circuit the gain of the op-amp is very high, hence V₁ drives the output of op-amp to its positive saturation +V_{sat}. The capacitor ‘C’ start charging towards +V_{sat} through resistor R. However as soon as the voltage across capacitor is slightly positive than V₁ the output of the op-amp is forced to switch to negative saturation – V_{sat}. The voltage V₁ across R₁ is also positive. Since,

\[ V₁ = \frac{R_1}{R_1+R_2} (-V_{sat}) \]

Thus, \[ V_{id} = V₁ - V₂ \]
The output remains in negative saturation until the capacitor ‘C’ discharges and then recharges to a negative voltage than $V_2$, the net difference voltage becomes positive and hence drives the output of op-amp back to its saturation $+V_{sat}$.

$$V_1 = \frac{R_1}{R_1 + R_2}(+V_{sat})$$

The time period $T$ of the output waveform is given as,

$$T = 2RC$$

The output frequency is,

$$f_o = \frac{1}{T} = \frac{1}{2RC}$$

CIRCUIT DIAGRAM:-

![Circuit Diagram](image)

**Figure:-** Square wave generator (Astable generator)

**FOR SQUARE WAVE GENERATOR (ASTABLE MULTIVIBRATOR)**

**PROBLEM :-** Design Astable multivibrator for $T = 940 \mu s$, $\beta = 0.473$, $R_1 = 10 \, k\Omega$, $C = 0.047 \mu F$.

Determine the value of $R_1$ & $R_2$.

**SOLUTION :-** Given $T = 940 \mu s$, $\beta = 0.473$, $R_1 = 10 \, k\Omega$, $C = 0.047 \mu F$

Since we know that,

$$T = 2RC$$
Therefore, 
\[
R = \frac{T}{2C} = \frac{940 \times 10^{-6}}{2 + 0.047 \times 10^{-6}}
\]
\[
R = 10 \, \text{K}\Omega
\]

\[
\beta = \frac{R_1}{R_1 + R_2}
\]

\[
0.473 = \frac{10 \times 10^3}{10 \times 10^3 + R_2}
\]

\[
R_2 = 11.14 \, \text{K}\Omega
\]

**PROCEDURE:-**

**FOR SQUARE WAVE GENERATOR (ASTABLE MULTIVIBRATOR)**

1. Mount square wave generator (astable multivibrator) circuit on bread board as per circuit diagram.
2. Connect CRO at the o/p terminal of the circuit.
3. Apply \( V_{CC} = 15V \) & \( V_{EE} = -15V \) from dual power supply.
4. Observe the output waveforms on the CRO.
5. Measure amplitude of waveform.
6. Draw waveforms on graph papers.
7. Switch off power supply.

**OBSERVATION:-**

Square wave o/p (Vo) =
RESULT:-
    So, at a given frequency we performed and tested the square wave and triangular wave generator.
    
    Square wave o/p (Vo) =

CONCLUSION:-

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ORAL BASED QUESTIONS

1. Which circuit is used as square wave generator?

2. What is the time period of square wave generator?

3. What is the gain of integrator at frequency \( f_b \)?

4. What type of feedback is used in astable multivibrator?

Sign.
AIM: - STUDY OF SCHMITT TRIGGER USING OP-AMP IC 741

OBJECTIVE: - OPAMP AS A SCHMITT TRIGGER

APPARATUS:-Function generator
    bread board,
    connecting wire,
    Ic 741,
    Dual power supply
    CRO
    Resistor

THEORY:-
The ckt which is used to avoid unwanted triggering is called **Schmitt trigger**.

Fig shows that the basic Schmitt trigger ckt. It is also called as inverting Schmitt trigger. This is because the i/p is applied to inverting terminal of Op-amp.

Inverting mode produces the opposite polarity o/p. This is feedback to Non inverting i/p, which is of same polarity as that of o/p.

If i/p voltage $V_{in}$ is slightly positive, this produces negative voltage to Non-inverting i/p. This increases error voltage resulting in large negative o/p voltage. This is again feedback. The process is cumulative & finally o/p gets driven into negative saturation. The positive feedback helps Op-amp to hold its existing o/p state at high or low depending on condition of i/p voltage $V_{in}$.

The feedback voltage $V_{ref}$ is

$$V_{ref} = \frac{R_2}{(R_1 + R_2)} V_{out}$$

Hence the feedback factor $\beta$ is

$$\beta = \frac{R_2}{(R_1 + R_2)}$$

But $V_{out}$ is $(+ V_{sat})$ for positive feedback

$$V_{ref} = (+\beta V_{sat})$$

For negative feedback

$V_{out}$ is $- V_{sat}$ hence

$$V_{ref} = (-\beta V_{sat})$$

The $+\beta V_{sat}$ is called upper trip point and denote by UTP.

The $-\beta V_{sat}$ is called lower trip point and denote by LTP.

$$UTP = +\beta V_{sat}$$

$$UTP = \left[\frac{R_2}{(R_1 + R_2)}\right] V_{sat}$$

$$LTP = - \left[\frac{R_2}{(R_1 + R_2)}\right] V_{sat}$$
CIRCUIT DIAGRAM:

PROCEDURE: -

1) Connect the component & instrument as shown in fig.
2) Apply the input vtg. Vin to 2 inverting terminal through function generator.
3) Apply the input vtg. Vin to 4 & 5 terminal through dual power supply.
4) Make time /div on XY mode
5) Apply ground to both input
6) Observe the o/p on CRO screen & measure the UTP & LTP

OBSERVATION:-

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Input voltage</th>
<th>Output voltage</th>
<th>+Vsat</th>
<th>-Vsat</th>
<th>UTP</th>
<th>LTP</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

CALCULATION

RESULT:-
CONCLUSION:-
ORAL BASED QUESTIONS

1. What is the o/p of Schmitt trigger circuit?

2. What type of feedback is used in Schmitt trigger circuit?

3. What is mean by UTP & LTP? Give equations for that.

4. Is it Schmitt trigger circuit is comparator? If yes then how?

Sign.
AIM:- Study of IC 555 Application- Astable, Monostable Multivibrator

APPARATUS: - Single power supply, Function generator, Bread board, CRO, CRO probes, connecting wires

<table>
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<tr>
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<td>10 KΩ</td>
<td>03</td>
</tr>
<tr>
<td>03</td>
<td>Capacitor</td>
<td>0.01 µF</td>
<td>02</td>
</tr>
<tr>
<td>04</td>
<td>Capacitor</td>
<td>0.1 µF</td>
<td>02</td>
</tr>
<tr>
<td>05</td>
<td>IC-555</td>
<td>------</td>
<td>02</td>
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</tbody>
</table>

THEORY:-

ASTABLE MULTIVIBRATOR:-

An astable multivibrator is often called as free running multivibrator. It is a rectangular wave generator. It does not require any external triggering to change state of o/p. The time during which the o/p is either high or low is determined by two resistors & capacitor externally connected to IC 555.

In astable multivibrator initially when o/p is high capacitor ‘C’ start charging towards Vcc through R_A & R_B. However as soon as voltage across capacitor equals 2/3 Vcc capacitor 1 trigger F/F & o/p goes low. Now capacitor ‘C’ starts discharging through R_B & Q_1 transistor. When vtg across ‘C’ equals to 1/3 Vcc comparator two’s o/p triggers F/F & o/p of F/F goes high then cycles repeats.

The time during which ‘C’ charges from 1/3 Vcc to 2/3 Vcc is the time at which o/p is high & is given by,

\[ tc = 0.69 \times (R_A + R_B) \times C \]  --------- 1)
Similarly the time during which capacitor ‘C’ discharges from \(2/3 \text{ Vcc}\) to \(1/3 \text{ Vcc}\) is the time at which o/p is low & is given by,

\[ t_d = 0.69 \, R_B C \]  

Thus the total period of o/p waveform is,

\[ T = t_c + t_d \]

\[ = 0.69 (R_A + 2R_B) \, C \]

& freq of oscillation is,

\[ F_o = \frac{1}{T} = \frac{1.45}{(R_A + 2R_B) \, C} \]

% Duty cycle = \( \frac{t_c}{T} \times 100 \)

\[ = \frac{R_A + R_B}{R_A + 2R_B} \times 100 \]

CIRCUIT DIAGRAM:-

Figure:-Astable multivibrator using IC-555

PROBLEM: - Design astable multivibrator for 66.7 % duty cycle with value of \(R_B\) is 10 KΩ, \(C = 0.1 \mu F\), \(C_1 = 0.01 \mu F\). Determine value of \(R_A\) & total time.

SOLUTION: - Given Duty cycle = 66.7 %, \(R_B\) is 10 KΩ, \(C = 0.1 \mu F\), \(C_1 = 0.01 \mu F\)

\[
\text{Duty cycle} = \frac{R_A + R_B}{R_A + 2R_B} \\
0.667 = \frac{R_A + 10}{R_A + 20} \\
R_A = 10.95 \, \text{KΩ}
\]
\[ R_A \approx 11 \text{K}\Omega \]

\[ T = t_c + t_d \]

\[ = 0.69 \left( R_A + 2R_B \right) C \]

\[ = 0.69 \left( 11 \times 10^3 + 10 \times 10^3 \right) 0.1 \times 10^{-6} \]

\[ T = 2.14 \text{ ms} \]

**MONOSTABLE MULTIVIBRATOR:**

Monostable multivibrator is often called as one shot multivibrator. It is a pulse generator ckt in which duration of pulse is determined by RC network connected externally to IC 555 timer. The monostable multivibrator has only one stable state.

Initially when the o/p is low i.e. ckt is in stable state Q1 is ON & capacitor ‘C’ is short ckt to zero. On application of negative trigger pulse to pin no. 2, Q1 turned OFF, which releases the short ckt across the external capacitor & drivers the o/p high.

The capacitor ‘C’ now starts charging towards Vcc through R_A when voltage across ‘C’ is 2/3 Vcc, comparators o/p switches from low to high. Which in turn drives the o/p to its low state via o/p of flip-flop? At the same time o/p of f/f turns Q1 ON & ‘C’ discharges rapidly through Q1. The o/p of monostable remains low until trigger pulse is again applied. Then the cycle repeats.

The time during which o/p remains high is given by,

\[ t_p = 1.1 R_A C \]

Voltage across capacitor is,

\[ V_c = V_{cc} \left( 1 - e^{-t/RC} \right) \quad \text{at} \quad t = T, \quad V_c = \frac{2}{3}V_{cc} \]

Therefore,

\[ \frac{2}{3} V_{cc} = V_{cc} \left( 1 - e^{-t/RC} \right) \]

\[ t = RC \ln (3) \]

\[ T = 1.1 RC \text{ sec} \]
CIRCUIT DIAGRAM:-

**Figure:** Monostable multivibrator using IC-555

**PROBLEM:** - Design monostable multivibrator for \( t_p = 1.1 \text{ msec} \), \( R_A = 10 \text{ K} \Omega \). Determine value of ‘C’.

**SOLUTION:** - Given \( t_p = 1.1 \text{ msec} \), \( R_A = 10 \text{ K} \Omega \)

\[
t_p = 1.1 R_A C
\]

\[
C = \frac{1.1 \times 10^{-3}}{1.1 \times 10^{-3}} = 0.1 \mu F
\]

**PROCEDURE:-**

**FOR ASTABLE MULTIVIBRATOR**

1) Mount the astable multivibrator circuit on bread board as per circuit diagram.
2) Apply \( V_{CC} = 10V \) from single power supply.
3) Connect CRO at the o/p terminal of the circuit.
4) Observe output & capacitor voltage waveforms simultaneously on the CRO.
5) Measure voltage & time from the waveforms.
6) Draw o/p voltage & capacitor waveform on graph paper.
7) Switch off power supply.
FOR MONOSTABLE MULTIVIBRATOR

1) Mount the monostable multivibrator circuit on bread board as per circuit diagram.
2) Apply $V_{cc} = 10V$ from single power supply.
3) Set square wave input as trigger pulse on function generator & give it to pin no.2 of the ckt.
4) Connect CRO at the o/p terminal of the circuit.
5) Observe output & capacitor voltage waveforms simultaneously on the CRO.
6) Measure voltage & time from the waveforms.
7) Draw o/p voltage & capacitor waveform on graph paper.
8) Switch off power supply.

OBSERVATION:-

FOR ASTABLE MULTIVIBRATOR

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Quantity</th>
<th>No of Division</th>
<th>Time/div</th>
<th>Total Period</th>
<th>Time</th>
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<tr>
<td>1</td>
<td>On Time ($t_c$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Off Time ($t_d$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Total Time ($T$)</td>
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</table>

FOR MONOSTABLE MULTIVIBRATOR

<table>
<thead>
<tr>
<th>V at pin 8</th>
<th>$V_C$</th>
<th>$t_c(T_{ON})$</th>
<th>$t_d(T_{OFF})$</th>
<th>$T = t_c + t_d$</th>
</tr>
</thead>
</table>
RESULT:-
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CONCLUSION:-
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1. Why timer IC is called as IC555?

2. What is astable multivibrator?

3. What is difference between astable multivibrator & monostable multivibrator?

4. What are the applications of astable multivibrator?
5. What is the equation for time period of monosable multivibrator?

6. What is the equation for duty cycle in astable multivibrator?
AIM: - STUDY OF IC 723 AS LOW VOLTAGE REGULATOR

APPARATUS:-

FOR LOW VOLTAGE REGULATOR:

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<tbody>
<tr>
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<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Resistor</td>
<td>1 KΩ</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2 KΩ</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Capacitor</td>
<td>68 pf</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1 µf</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Load resistor</td>
<td>10 KΩ</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Regulated power supply</td>
<td>(0-30V)</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Multimeter</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Bread board</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Single stand wire</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THEORY:

FOR LOW VOLTAGE REGULATOR:

The current limit transistor remains non-conductive unless voltage drops across Rse is 0.6V. the value of Rsc can be found out by following equation

\[ R_{sc} = \frac{V_{se}}{I_{limit}} \]

\[ = 0.6/I_{limit} \]

Potentional divider made up of R1<R2 is connected between Vref and non-inverting terminal

\[ V_{\text{non-inverting}} = V_{\text{ref}} \times \frac{R_2}{R_1+R_2} \]

As positive series pass transistor is working working as emitter follower.
\[ V_0 = V_{ref} \frac{R_2}{R_1 + R_2} \]

\( R_1 \) and \( R_2 \) can be between 1kΩ to 10KΩ

\[ R_3 = R_1 \frac{R_2}{R_1 + R_2} \]

**Circuit Diagram:**

![Circuit Diagram](image)
OBSERVATION TABLE:-

FOR LOW VOLTAGE REGULATOR:

Line regulation:

<table>
<thead>
<tr>
<th>$V_{in}$</th>
<th>$V_{out}$</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

RESULT:-

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---------------------------------------------------------------------------------------------------------------

CONCLUSION:-

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---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------------------
1. Define load regulation and line regulation.

2. What are advantages of IC voltage regulators?

3. Classification of IC voltage regulator?
SSBT’s College of Engineering & Technology, Bambhori, Jalgaon

Department of Electrical Engineering

Name of Student: Class: Roll No:

Exp. No. Date of Performance: Date of Completion:

AIM: - STUDY OF IC 723 AS HIGH VOLTAGE REGULATOR

APPARATUS:-

FOR HIGH VOLTAGE REGULATOR:

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>IC 723</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Resistor 1 KΩ</td>
<td>1 KΩ</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Resistor 2.2 KΩ</td>
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<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Capacitor 68 Pf</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Load resistor 10 KΩ</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Regulated power supply</td>
<td>(0-30V)</td>
<td>1</td>
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<tr>
<td>6</td>
<td>Multimeter</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Single stand wire</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THEORY:

FOR HIGH VOLTAGE REGULATOR:

For this type output voltage varies from +7V and +37V and I ≤ 100mA

The non-inverting terminal connected to Vref. Through Rb. Due to this arrangement the error amplifier acts as non-inverting amplifier.

The gain A = 1 + R₁/R₂

The output voltage is

\[ V_0 = V_{ref} \left(1 + \frac{R_1}{R_2}\right) \]

\[ R_{sc} = 0.6/\text{limit} \]

\[ R_3 = R_1 \cdot R_2 / (R_1 + R_2) \]
CIRCUIT DIAGRAM:

Fig. High Voltage regulator
OBSERVATION TABLE:-

FOR HIGH VOLTAGE REGULATOR:

Line regulation:

<table>
<thead>
<tr>
<th>$V_{\text{in}}$</th>
<th>$V_{\text{out}}$</th>
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</thead>
<tbody>
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</tbody>
</table>

RESULT:-

CONCLUSION:-
ORAL BASED QUESTIONS

1. Explain the applications of IC 723

2. Discuss the features of IC 723?

3. Explain the principles of SMPS?

Sign.
SSBT’s College of Engineering & Technology, Bambhori, Jalgaon

Department of Electrical Engineering

Name of Student:                                                  Class:                                                   Roll No:
Exp. No.                                                   Date of Performance:                            Date of Completion:

AIM: STUDY OF VOLTAGE REGULATOR USING IC 78××

OBJECTIVE: STUDY OF IC 7805 AS FIXED VOLTAGE REGULATION

APPARATUS: Bread board
Connecting wires,        
IC 7805
DC power supply
multimeter.

THEORY:

The voltage regulator is a circuit that supplies a constant voltage regardless of change in load currents. Voltage regulators are commonly used for on-card regulation and laboratory type power supply. Voltage regulator especially switching type, are used as control ckt in pulse width modulation(PWD), push pull bridges, and series type switch mode supplies.

Positive voltage regulator series with seven voltage option.

The 78×× series consists of three terminal positive voltage regulators with seven voltage option. 7 indicates that the series connection of the SC is consists of three pin. The two no. ×× indicates the output voltage

<table>
<thead>
<tr>
<th>Device type</th>
<th>Output voltage (Volts)</th>
<th>Max input voltage (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7805</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>7806</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>7808</td>
<td>8.0</td>
<td>35</td>
</tr>
<tr>
<td>7812</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>7815</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>7818</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td>7824</td>
<td>24.0</td>
<td>40</td>
</tr>
</tbody>
</table>

These ICs are designed as fixed voltage regulators with adequate heat sinking can deliver output current in the excess of 1A. Although these devices do not required
external component. Such component can be used to obtain adjustable voltages and currents, these ICs also have internal thermal overload protection and internal short ckt current limiting proper operation require a common ground between input and output voltages. The difference between input and output voltages is called dropout voltage. the capacitor Ci is required if the regulator is located an appreciable distance from power supply filter. even though Co is not needed it may be used to improve response of regulator.

Typical performance parameters for voltage regulators are line regulation, load regulation, temperature stability, and ripple rejection. Line or input regulation is defined as the change in output voltage for change in the input voltage. Load regulation is the change in load current. Temperature stability is the the change in output voltage per unit change in temperature. Ripple rejection is the measure of a regulator ability to reject ripple voltages. The 7800 regulators can also be used as current sources.

CIRCUIT DIAGRAM:

Positive voltage regulator

PROCEDURE:

I.) For fixed voltage regulator.
II.) Connect the component & instrument as shown in fig.
III.) Give the i/p voltage and increase it gradually
IV.) Observed that o/p in each case & plot positive graph.
OBSERVATION:
Positive voltage regulator

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>INPUT VOLTAGE(Vin)</th>
<th>OUTPUT VOLTAGE(Vo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<td>2.</td>
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<td>12</td>
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<td>13</td>
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</tbody>
</table>

RESULT:

______________________________________________________________________________
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CONCLUSION:

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______________________________________________________________________________
______________________________________________________________________________
1. Application of IC 78XX.

2. What voltage options are available in 78xx voltage regulators?

3. Explain how IC 7805 can be used to obtain 5V positive power supply?
AIM: STUDY OF VOLTAGE REGULATOR USING IC 79 × ×

OBJECTIVE: STUDY OF IC 7905 AS FIXED VOLTAGE REGULATION

APPARATUS: Bread board
Connecting wires,
IC 7905
DC power supply
multimeter.

THEORY:
The voltage regulator is a circuit that supplies a constant voltage regardless of change in load currents. Voltage regulators are commonly used for on-card regulation and laboratory type power supply. Voltage regulator especially switching type, are used as control ckt in pulse width modulation(PWD), push pull bridges, and series type switch mode supplies.

Negative voltage regulator series with nine voltage options.
7900 series of fixed output voltage regulators are complements to the 7800 series devices. These negative regulators are available in the same seven voltage option as the 7800 devices. In addition two extra voltage option -2.0 volt and -5.2 volt also available in the negative 79000series,

<table>
<thead>
<tr>
<th>Device type</th>
<th>Output voltage (Volts)</th>
<th>Max input voltage (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7902</td>
<td>-2.0</td>
<td>35</td>
</tr>
<tr>
<td>7905</td>
<td>-5.0</td>
<td></td>
</tr>
<tr>
<td>7905.2</td>
<td>-5.2</td>
<td></td>
</tr>
<tr>
<td>7906</td>
<td>-6.0</td>
<td></td>
</tr>
<tr>
<td>7908</td>
<td>-8.0</td>
<td></td>
</tr>
<tr>
<td>7912</td>
<td>-12.0</td>
<td></td>
</tr>
<tr>
<td>7915</td>
<td>-15.0</td>
<td></td>
</tr>
<tr>
<td>7918</td>
<td>-18.0</td>
<td></td>
</tr>
<tr>
<td>7924</td>
<td>-24.0</td>
<td>40</td>
</tr>
</tbody>
</table>
CIRCUIT DIAGRAM:

Negative voltage regulator

PROCEDURE:

V.) For fixed voltage regulator.
VI.) Connect the component & instrument as shown in fig.
VII.) Give the i/p voltage and increase it gradually
VIII.) Observed that o/p in each case & plot positive graph.

OBSERVATION:

Negative voltage regulator

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>INPUT VOLTAGE(Vin)</th>
<th>OUTPUT VOLTAGE(Vo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
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<td>3</td>
<td></td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
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<td>12</td>
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<td>13</td>
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</tbody>
</table>
RESULT:

______________________________________________________________________________
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CONCLUSION:

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ORAL BASED QUESTIONS

1. Application of IC 79XX.

2. What voltage options are available in 79xx voltage regulators?

3. Explain how IC 7905 can be used to obtain -5V negative power supply?

Sign.
AIM: STUDY OF J-K Flip Flop.


APPARATUS:

  - Bread board,
  - Connecting wires,
  - IC 7476,
  - LED’s.

THEORY:

A J-K flip-flop is refinement of R-S flip-flop. In S-R f/f from the condition S=R=1 is not allowed , A J-K flip-flop J and K input behaves like input S and R to set and reset the flipflop respectively.

When J and K both Low , both AND gates are disabled. Therefore clock pulse have no effect and Q and Q retain there last values.

When J is low  and K is high the lower AND gate is reset when Q is high , the upper gate passes a RESET trigger as soon as next positive clock pulse arrives this forces Q to become low. Therefore, J=0 and K=1 means that reset the flipflop unless Q is already reset.
When J is high and K is low, the upper gate is disable, so there is no way to reset the flipflop; the only possibility to set the flipflop. With Q=0, $\overline{Q}=1$ and hence the lower gate passes a SET trigger on the next positive clock pulse. This drive Q into the high state. Therefore, J=1 and K=0 means that the next positive clock pulse sets the flipflop unless Q is already set.

When J and K are both high it is possible to set or reset the flipflop. If Q is high, the upper gate passes a RESET trigger on the next positive clock edge. When Q is low, the lower gate passes a SET trigger on the next positive clock edge. Q changes to the complement of the last state. Therefore, J=1 and K=1 means output of the flipflop toggle on the next positive clock edge.

**LOGIC CIRCUIT:**

**PROCEDURE:**

1.) Connect the component & instruments as shown in fig.
2.) Give power supply of 5v.
3.) Observe the o/p in each case. (before occurrence and after occurrence of clock pulse)
4.) Verify truth table of each case.
Truth Table

<table>
<thead>
<tr>
<th>Preset</th>
<th>clear</th>
<th>CP</th>
<th>J</th>
<th>K</th>
<th>Q_{n+1}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Result:

Conclusions:
1. What is the difference between latches and flip-flops?

2. Explain truth table of J-K flip-flop?

3. Define setup time, hold time and propagation delay?

4. What are the applications of flip-flop?

Sign.
SSBT’s College of Engineering & Technology, Bambhori, Jalgaon

Department of Electrical Engineering

Name of Student: ____________________________ Class: ____________________________ Roll No: ____________________________

Exp. No. ____________________________ Date of Performance: ____________________________ Date of Completion: ____________________________

AIM: verification of binary counter IC-7493.

APPARATUS: Bread board, Resistor, LED’s, Connecting wires.

THEORY:

When \( N = 2^n \) then it is called as binary counter. It is counter designed before prepare always sequence table if \( N = 2^n \) then it is binary counter the no. of state 16.

The o/p of FF3 is connected to i/p of FF2 is connected to o/p of FF1 NAND gate are used to given i/p are \( R_1 = R_2 \) & o/p \( Q_3 , Q_2 , Q_1 \) & \( Q_0 \) as shown in fig.

LOGIC CIRCUIT

![Logic Circuit Diagram]

PROCEDURE:

1.) Connect the ckt. as shown in fig.
2.) Give the i/p supply of v volt.
3.) Apply ground to both i/p.
**OBSERVATION TABLE:**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Q0</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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RESULT:

______________________________________________________________________________
______________________________________________________________________________
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CONCLUSION:

______________________________________________________________________________
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______________________________________________________________________________
ORAL BASED QUESTIONS

1. Logic diagram of IC 7493

2. Explain modes of IC 7493

3. What are asynchronous counters?